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DEPARTMENT OF COMMERCE AND LABOR

BUREAU OF FISHERIES

GEORGE M. BOWERS, *Commissioner*

AMERICAN CATFISHES: HABITS,
CULTURE, AND COMMERCIAL
IMPORTANCE

Bureau of Fisheries Document No. 733



WASHINGTON
GOVERNMENT PRINTING OFFICE
1910



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GEORGE M. BOWERS, Commissioner

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by
William Converse Kendall.

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By WILLIAM CONVERSE KENDALL,

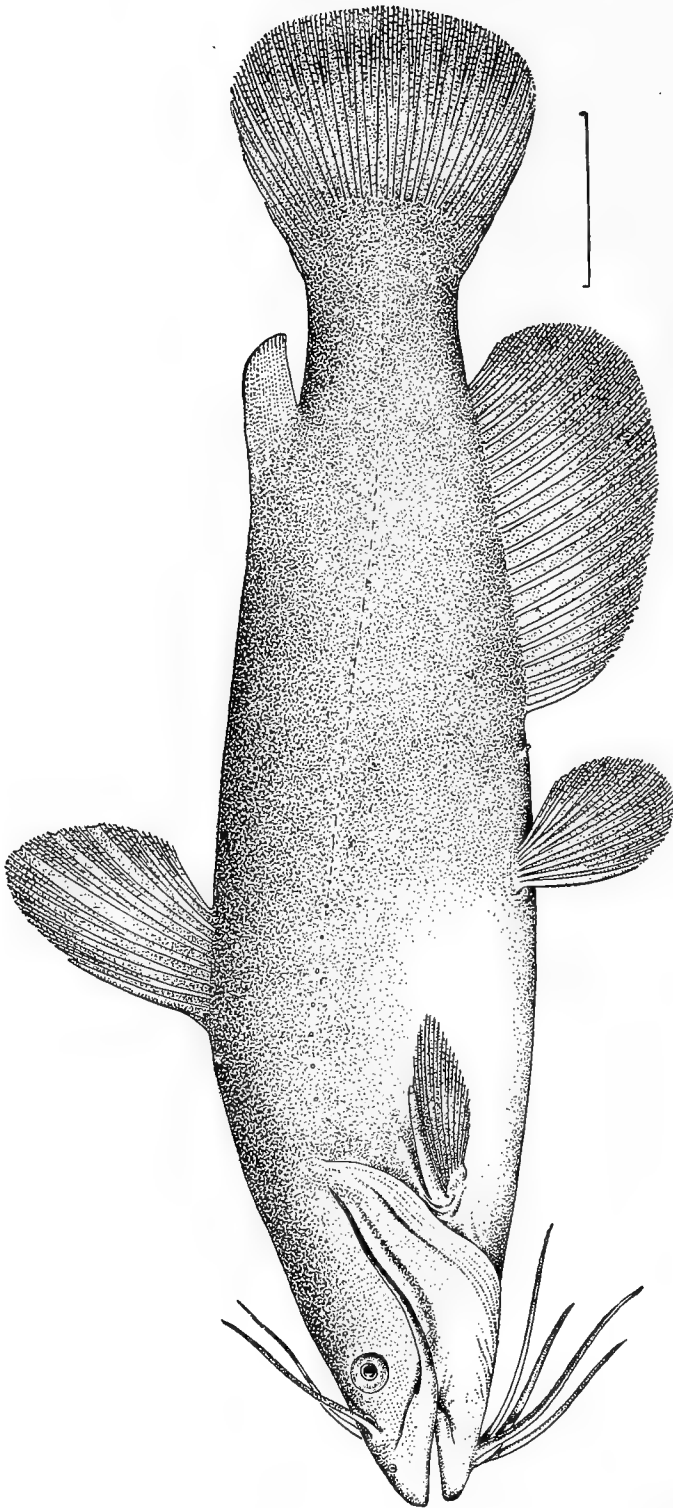
Assistant, United States Bureau of Fisheries

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AMERICAN CATHOLIC LEAGUE
CONFIDENTIAL

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COMMON BULLHEAD (*Ameiurus nebulosus*).

AMERICAN CATFISHES: HABITS, CULTURE, AND COMMERCIAL IMPORTANCE.

By WILLIAM CONVERSE KENDALL,
Assistant, United States Bureau of Fisheries.

IMPORTANT SPECIES.

The catfishes are of such commercial value as food that there have arisen extensive and almost special fisheries for them in the South, the Mississippi Valley, and the Great Lakes region; that is to say, in the centers of their greatest abundance. There is, however, very little published information on the habits of any species of catfish, and it has been thought desirable to bring together the most important published and otherwise available facts on this subject.

The fresh-water catfishes of the United States of more or less commercial importance may be classified in a popular way as channel cats (*Ictalurus*), mud cats (*Ameiurus*), yellow cats (*Leptops*), and stone cats (*Noturus*). This arrangement is not wholly satisfactory, however, owing to the confusion of the common names, for a mud cat of one locality may be the yellow cat of another, and the yellow cat here may be the stone cat somewhere else, etc.; then, too, there is no distinct line between channel cats and mud cats. The technical nomenclature and synonymy of these fishes are not in much better condition than the popular classification; therefore the discussion in the following pages will be more or less generic. Owing to the similarity of habits, moreover, it is unnecessary to discuss more than the most common forms except in a very general way.

The catfishes are a hardy race, very prolific, and in habits and structure comparatively safe from enemies. For these reasons wherever they occur they are usually very abundant. In late years, however, the demand for these fish has reached such dimensions that in some localities extensive inroads have been made upon their numbers and there has arisen the problem of how to repopulate the depleted waters. It has not, until recently at least, been considered necessary to resort to artificial propagation of catfishes, and there have been but few, if any, attempts in that direction. There are a few instances of pond culture, which will be referred to in another place.

Of about a dozen species appearing in the markets, probably not more than one-half are very common or merit more than passing

notice. The largest are the "great forked-tail cat" of the Mississippi (*Ictalurus furcatus*), the Great Lakes cat (*Ameiurus lacustris*), and the yellow cat (*Leptops olivaris*). The first attains a weight of 150 pounds, the second 100 pounds, and the others perhaps 50 pounds or more. Of the other cats the more important are the spotted cat (*Ictalurus punctatus*), Potomac channel cat or white catfish (*Ameiurus catus*), bullhead (*Ameiurus nebulosus*), and the marbled cat (*Ameiurus marmoratus*). Of less importance are the black bullhead (*Ameiurus melas*), yellow catfish or yellow bullhead (*Ameiurus natalis*), brown catfish (*Ameiurus platycephalus*), black catfish (*Ameiurus erebennus*), and the eel cat (*Ictalurus anguilla*).

Ameiurus marmoratus has heretofore usually been regarded as a variety of *A. nebulosus*, but the writer, basing his views on an examination of many individuals of both forms, believes the marbled cat is a distinct species. While for fish cultural purposes the name is not of much consequence, the distinctness of the two species, if a fact, is of considerable moment, as the marbled cat might and probably does require somewhat different treatment or methods of handling in pond culture. It may be said that there is considerable difference in structure, and supposed intergradation in color is assumed from the fact that some individuals of the common bullhead in their color markings (nebulations) somewhat resemble those of the marbled cat; and the marbled cat attains a much larger size than the common bullhead.

There are also two species of salt-water catfish, one of which, at least, in late years has attained some commercial importance. These are the gaff-topsail cat (*Felichthys marinus*) and the sea catfish (*Galeichthys milberti*). Their commercial importance is not great, but they doubtless form a portion of the records of the catfish fisheries.

Catfish are preeminently a poor man's fish. They not only afford him a cheap food fish, but become so abundant in time and there is so much demand for them that they support a paying industry, notwithstanding their cheapness. They may be raised in artificial ponds or in ponds unsuited to other fish. They propagate rapidly and prolifically and grow fast. There can be no objection to the introduction of them into waters unsuited to other fishes or in which other fishes do not occur, provided there is no danger of escape into waters where they would prove an undesirable acquisition.

HABITAT.

Almost any one of the species of catfishes seems to be adapted to a wide range of climatic conditions, although somewhat restricted to certain immediate surroundings. *Ameiurus lacustris* is supposed to be distributed from the Saskatchewan River and the Great Lakes

to Florida. *Ameiurus nebulosus* is found from Maine to Florida. In Maine, however, this species occurs as a rule only in muddy lakes and streams with plenty of vegetation and such portions of bodies of water of other character as afford those conditions, and apparently the fish do not stray far from home. Such localities are probably the warmest ones of the region. Regarding the local habitat of *Ameiurus nebulosus*, Dean says:^a

It is one of the hardiest of fishes, will care for itself and even thrive in the muddiest of stagnant waters. It will breed readily and will endure complacently every hardship of drought, extremes of temperature, and lack of food.

Every trait of our catfish bespeaks its stagnant mud-loving nature; dusky in color, sluggish, and blundering, furnished with long and tactile barbels, a shallow, slowly drained pond, furnished with an occasional deep mud hole, will suit admirably the needs of the fish. If the water does become warm in the summer, the catfish will survive; knowing how to survive is one of its especial virtues. In a 3-foot aquarium at college about a dozen 9-inch catfish were kept during very warm weather, the room temperature often in the nineties and the water changed but once a day, with but few fatal results. Should the air supply in the water fail, trust the fish to care for itself. It will come to the surface, leisurely renew the air in its swim bladder, and even, frog-like or turtle-like, swallow air in bulk, trusting to stomach respiration. Of undoubted respiratory value, moreover, must be the scaleless, highly vascular skin, so important in the breathing economy of the frogs. Should the pond dry, and the whole pond basin be serried with mud cracks, the catfish will lie dormant for days, even for weeks. It has been found in a clod of mud, which served as a cocoon, until softened by the return of the water. In winter the catfish, like frogs, and unlike many of its neighbors, appears to hibernate. In November it becomes sluggish and refuses food, and early in December buries itself in the deepest ooze of the pond. It does not reappear till the first sharp thunderstorm in February or March. Then the fish are seen, thin and ravenous, approaching the shore so closely that their heads ripple the surface. So fearless are they in early spring in Central Park that they come in schools in shallow water and will take food almost from the hand.

Of this species Forbes and Richardson^b say:

It is peculiar in its preference for stagnant waters, of both lowland and upland lakes and ponds, and it is next commonest in the larger streams.

According to Forbes and Richardson, the black bullhead (*Ameiurus melas*) in the main features of its distribution agrees with the yellow bullhead, being, like that species, decidedly most abundant in creeks and least so in the larger rivers, and also showing a notable preference for the more quiet and muddier parts of the streams it inhabits.

The channel cats are so called owing to their apparent preference for channels of streams and clearer, cleaner water than that affected by the majority of so-called mud cats, though the native channel cat of the Potomac River, according to our present classification, is generically a mud cat (*Ameiurus*). In some southern rivers, the St. Johns in particular, several genera of catfish occur together with precisely the same kind of surroundings, whether muddy or sandy.

^a Dean, Bashford: Notes on the common catfish, Nineteenth Annual Report State Fish Commission, New York, 1890, p. 302.

^b Forbes, S. A., and Richardson, R. E.: The fishes of Illinois. Natural History Survey of Illinois, vol. III, ch. CXXXI, 357 p., 1908.

The spotted cat (*Ictalurus punctatus*), previously mentioned as one of the most highly esteemed channel cats, thrives best in streams. Regarding this species Jordan^a says:

The channel cat abounds in all flowing streams from western New York westward to Montana and southward to Florida and Texas. It is perhaps most common in Tennessee, Arkansas, and Missouri. It seems to prefer running waters, and young and old are most abundant in gravelly shoals and ripples. The other catfishes prefer sluggish waters and mud bottoms. I have occasionally taken the channel cat in ponds and bayous, but such localities are apparently not their preference. They rarely enter small brooks unless these are clear and gravelly. Whether they will thrive in artificial ponds we can only know from experiment.

Forbes and Richardson (op. cit.) state of the spotted cat that it lives in clear, swift-flowing water, and for this reason and for the fact that it is a "trimmer" and more active fish than any of the related species, it is well esteemed by anglers in many localities.

Evermann (op. cit.) states that in Louisiana the blue cat (*Ictalurus furcatus*) and goujon (*Leptops olivaris*), called also yellow cat, are influenced in their movements by the temperature of the water. During the winter they come farther down the river, where the water is warmest, and in the summer they run farther upstream or retire to the deeper waters. The goujon is said to be most abundant in the Atchafalaya River from September to November, or until the fall floods begin, when it gradually disappears. This is the best season for catching, although a few may be found at any season. The best fishing for the blue cat, on the other hand, is said to be during the high water in the spring. These fish leave the rivers, lakes, and bayous and take to the woods. Good "woods" or "swamp" fishing is sometimes had as early as March.

The blue catfish of the Mississippi Valley and Southern States, as stated elsewhere, attains a weight of at least 150 pounds and is of considerable importance in that region. According to Forbes and Richardson (op. cit.), it frequents the deeper waters of the river channels, coming out into the river sloughs and backwaters in spring. The goujon is an abundant species in parts of the Mississippi basin and in the Gulf States, and is one of the most important catfishes in certain localities. Regarding this fish the same authors state that it is most abundant in the lower course of the larger streams, and in the bayous and overflow ponds of the lower Mississippi Valley.

Evermann states that the blue cat and the goujon are by far the most important species of the Atchafalaya River, Louisiana, and probably constitute 98 per cent of the entire catch. According to the same authority, the maximum size of the blue cat is about the same as that of the goujon. The largest of which Evermann

^a Jordan, David Starr: The habits and the value for food of the American channel catfish (*Ictalurus punctatus* Rafinesque). Bull. U. S. Fish Commission, vol. v, 1885, p. 34.

heard weighed 100 pounds. The largest seen by him was a ripe female weighing 35 pounds. A spent female, 31 inches long, weighed 22 pounds and dressed 13 pounds. Another spent female, 30 inches long, weighed 17 pounds. The goujon, Evermann says, rarely reaches a weight of 100 pounds, but examples of 50 or 60 pounds weight are said to be not unusual. The largest individual seen by him was a ripe female 41 inches long and weighing 48 pounds. It dressed 27 pounds. One 38 inches long weighed 37 pounds and another 37 inches long weighed $36\frac{1}{2}$ pounds.

The eel cat (*Ictalurus anguilla*) was first discovered in Louisiana by Evermann, but it was later found in the Ohio River at Louisville, Ky. Evermann states that it rarely weighs over 5 pounds and never over 8 pounds.

Large so-called eel cats in Texas were identified by Evermann as the blue cat (*Ictalurus furcatus*). More recently Forbes and Richardson record the eel cat in Illinois, and report that H. L. Ashcock, of Alton, says that fishes of this species weighing 26 pounds are taken at Alton and Grafton, where they are sometimes called "niggerlips" by the fishermen.

Of the four commercial catfishes taken in the Atchafalaya River, Louisiana—viz, blue cat, goujon, eel cat, and spotted cat—the eel cat stands third in commercial importance, Evermann states, the relative importance of the others being in the order enumerated.

The yellow catfish (*Ameiurus natalis*) ranges from the Great Lakes region to Virginia and Texas. It is abundant in many places and doubtless appears in the markets with others of its congeners.

According to Smith,^a the brown catfish (*Ameiurus platycephalus*) has a restricted range, embracing only the streams from Cape Fear River to the Chattahoochee. Its maximum length is somewhat over 1 foot. It is abundant in some places and is largely used as food. Its commercial importance, however, owing to its restricted distribution, is doubtless limited.

The black catfish (*Ameiurus erebennus*) inhabits coastwise waters from New Jersey to Florida, having a maximum length of about 1 foot. In Florida, especially in the St. Johns River, it is one of the important catfishes.

Smith says (op. cit.) regarding the white catfish (*Ameiurus catus*):

This species, whose form and color vary with age and environment, inhabits coastwise fresh waters from New Jersey to Texas. * * * The maximum length is 2 feet. * * * As food, this is one of the best of the catfishes, although its commercial importance in North Carolina is comparatively slight, owing in part to the abundance of other desirable fishes and in part to the fact that most of the catfish are caught where shad, alewives, and striped bass are receiving special attention.

^a Smith, H. M.: Fishes of North Carolina. North Carolina Geological and Natural History Survey, vol. II, 1907.

FOOD AND FEEDING HABITS.

The catfishes subsist upon either animal or vegetable food. In a strictly wild state the food is probably to a great extent animal, but in artificial inclosures they will eat almost any kind of vegetable matter fed to them.

Mr. J. F. Jones, of Hogansville, Ga., a correspondent of the Bureau of Fisheries quoted elsewhere (Bull. U. S. Fish Commission, vol. iv, 1884, p. 321), remarks regarding his domesticated catfish:

The species is easily tamed or domesticated. They can be trained like pigs—increase and grow fat when well supplied with food. They subsist upon vegetation, but in the absence of it can be fed upon any kind of fruit, such as peaches, apples, persimmons, watermelons, and the like, corn, wheat, and sorghum seed. I put fifty 3 inches long in a basket and set it in my pond. I fed them well on corn shorts and dough. In the short space of six weeks they grew to be 6 and 7 inches long and trebled in weight.

Regarding the “yellow bullhead” (*Ameiurus natalis*), Forbes and Richardson write:

The food and habits of this species and the brown bullhead are virtually identical.

As illustrated by the food of a dozen specimens, this species has the habits of a scavenger. One of these fishes had gorged itself with the waste of a fish boat, and one had made the greater part of its last meal from the remnants of a dead cat. Three of these specimens had eaten fishes taken alive, and 4 others had eaten crawfishes. May-fly larvæ and a few water snails were the only other objects worth mentioning. Seven young specimens, from 2 to 3½ inches long, had fed principally on entomostraca, the remainder of their food being chiefly small mollusks and insect larvæ.

As to the food of the common bullhead (*A. nebulosus*), Forbes and Richardson state as follows:

The food of 13 specimens examined by us was unusually simple for that of a catfish, consisting chiefly of small bivalve mollusks, larvæ of insects taken upon the bottom, distillery slops, and accidental rubbish. One of the specimens had eaten 18 leeches, leeches appearing in the food of 4 others, and a few had taken terrestrial insects and univalve mollusks.

Jordan (loc. cit.) says *Ictalurus punctatus* is an omnivorous fish, though less greedy than its larger-mouthed relatives, and that it feeds on insects, crawfishes, worms, and small fishes, and readily takes the hook.

Forbes and Richardson say:

Our knowledge of its food is based upon an examination of 43 specimens taken from the Illinois and Mississippi rivers during the spring, summer, and autumn months of 1878, 1880, and 1887. About one-fourth of the food consisted of vegetable matter, much of it miscellaneous and accidental. Three specimens, however, had eaten nothing but algæ, and fragments of pond weed (*Potamogeton*) made 20 per cent of the food of another three. A single fish had fed on stillhouse slops; and a dead rat, pieces of ham, and other animal débris attested the easy-going appetite of this thrifty species.

Pieces of fish were found in all of this group, commonly, however, of so large a size as to make it certain that they were the débris of the fishing boats. Occasionally fishes, evidently taken alive, composed the whole food. Mollusks, about equally large

water snails and large thin clams (probably in most cases *Anodonta*) were a decidedly important element, being found in 15 of the 43 fishes. They amounted to 15 per cent of the food of the group, and several specimens had taken little or nothing else. Notwithstanding the number of bivalves eaten by this fish, no fragment of a shell was ever found in their stomachs, but the bodies of the mollusks seem to have been separated, while yet living, from the shells, as indicated by their fresh condition and by the fact that the shell muscles were scarcely ever present. Fishermen say that they are often first notified of the presence of catfishes in their seines by seeing fragments of clams floating on the surface, disgorged by the struggling captives. Still more interesting and curious is the fact that the spiral-shelled mollusks found in the stomachs of these fishes were almost invariably naked, the more or less mutilated bodies having only the opercles attached. The shells are evidently cracked in the jaws of the fish and rejected before the food is swallowed. As many as 120 bodies and opercles of water snails (*Melantho* and *Vivipara*) were taken by us from the stomach of a single Illinois River catfish. Insects were, however, a principal food of the specimens studied, making 44 per cent of all, and eaten by 28 fishes. Five, in fact, had eaten nothing else, and others had taken 90 per cent or more of insects, mostly aquatic, although now and then a fish had filled itself with terrestrial specimens. Most of the aquatic insects were larvæ of mayflies, dragon flies, and gnats, to be found only on the bottom. Our records indicate that this fish spawned in May in 1898 (Craig). The spawning season in the Wabash is said by Doctor Jordan to begin in June. * * *

The channel cat is taken very frequently in bait nets and baskets, the former being called by the fishermen "fiddler nets." These are baited usually with "dough balls," made by mixing flour and water, allowing the paste to sour, and then baking it; or, in summer, with roasting ears of corn which become sour after soaking in water for a day or so. The sour smell of either the dough or the corn is said to be especially attractive to this fish.

In some localities the mud cats swarm about the mouths of sewers and other places, where they obtain refuse and offal. This garbage-eating habit is, however, not confined to the mud cats, the channel cats also occasionally indulging their tastes in that direction. Slops from the galley and refuse from the toilet rooms of the *Fish Hawk* in the St. Johns River, Florida, formed a great attraction for the two principal catfishes of that region (*Ameiurus catus?* and *Ictalurus punctatus*). It is doubtful whether the food, however foul, taints the flesh in any way, and this allusion to some apparently disgusting feeding habits can not consistently lead anyone who is fond of pork or chicken to forego the catfish solely on this account. Besides it is only occasionally and locally that these fish have access to such food.

Mr. Charles Hiester^a says that catfish appear to live on the larvæ of insects and on flies that fall into the water. "They never jump out of the water."

Writing of *Ameiurus nebulosus*, Dean (loc. cit.) says:

The habits of the catfish make it a most objectionable neighbor. * * * The stomach contents show its destructiveness to fish eggs and to young fish. * * * It will eat incessantly, day and night, prowling along the bottom with barbels widely spread. It will suddenly pause, sink headforemost in the mud for some unseen prey. Nor is it fastidious in its diet, "from an angleworm to a piece of tin tomato can," it bolts them all. From the contents of miscellaneous catfish stomachs, however, there

^a Letter in Bull. U. S. Fish Commission, vol. II, 1882, p. 76-77.

appears to exist a general preference for fish food. Professor Goode has already noted the attractiveness of salt mackerel or herring bait. He has, moreover, hinted incidentally that the fish will not bite when an east wind is blowing. It is in order to procure food in a lazy and strategic way that the catfish has been seen to sink in the mud with but barbels and dusky forehead exposed, ready to rush out and swallow the unwary prey.

In the Atchafalaya River region in Louisiana, Evermann says the impression prevails among the fishermen that the blue cat and goujon run out over the flooded districts on account of the more abundant food supply to be found there, which consists chiefly of crawfish inhabiting the shallow pools and ponds made accessible to the catfish through the agency of the floods. He further states that the goujon is more voracious than the blue cat, and large individuals are apt to feed upon smaller blue cats when confined in the same car. To prevent this, it is said that the fishermen sometimes sew up with wires the mouths of the very large goujon.

According to Forbes and Richardson the goujon lives and feeds on or near the bottom, and the fishermen at Havana, Ill., say that they frequently find it in hollow logs; that fishes are so far as known its principal food, and among those eaten by it they had observed a common river sunfish (*Lepomis*), several minnows, and a bullhead.

Regarding the blue cat the same authors state that a specimen examined by Kofoed had eaten fragments of bark (20 per cent), insect fragments and larvæ (50 per cent), and miscellaneous organic débris, and the senior author found fishes only in the stomach of a specimen taken in 1887.

In their feeding habits all species of catfish seem to be more or less nocturnal. They take a hook most readily from about twilight on into the night. Most set-line fishing is carried on at night. Moonlit nights, however, are more favorable than dark ones. On the St. Johns River it was noticed that the fish would begin to rise shortly after sunset, in large numbers, and the sound of their "breaks" could be heard in all directions, although a lot of garbage thrown overboard would not fail to raise more or less of them during the day. The catfish here were wary of a baited hook, and although freely eating of pieces of bread or meat floating at the surface, would never touch this if a hook and line were attached. Yet a hook baited with meat or fish and sunk would usually be satisfactorily effective, especially if "bream" (*Lepomis*) began to bite first. The presence of other more readily biting fish seemed to attract the catfish and render them bolder. Large catfish would take a small baited "bream" hook much more quickly than they would a large hook. The mud cat here bit no more greedily than the channel cat. It might be well to state in this connection that the channel cats (*Ictalurus punctatus* and *Ictalurus furcatus*) are sufficiently game fighters to give an angler

not too fastidious a very satisfactory battle. These two species might justly be classed as game fishes.

In northern lakes and streams the bullhead or hornpout does not always seem to be so wily as the southern catfishes were usually during the daytime. Although the best time to angle for hornpout is about dusk or after dark, they are not infrequently caught in the daytime, much to the annoyance of the "still fisher" for black bass, pickerel, and other fishes. When bullheads begin to bite, if other fish are desired, it is necessary to seek another place. They will take live-fish or dead-fish bait or frogs with equal readiness. If, however, bullheads are wanted, angleworms are the best bait.

SPAWN-EATING HABITS.

Dean has referred to the fish-egg-eating propensity of *Ameiurus nebulosus*. This species is not alone in its ovivorous habit. A seine haul on the Potomac River was estimated to contain about 10,000 catfish (*Ameiurus catus* and *Ameiurus nebulosus*), a large number of which were opened and their stomach contents examined. The fish were found to have been feeding almost exclusively upon herring (*Pomolobus*) eggs, to such an extent that their stomachs were distended with the food. Mr. L. G. Harron, at whose fishery this observation was made, told the writer that although these large hauls were not frequent, occasionally much larger ones were made. In Albemarle Sound, during one shad season, the writer frequently found catfish full of shad roe, but catfish were not abundant at this time.

Writing of the white catfish Smith says:

During the spring fishing season, many are caught in seines hauled for shad and alewives, especially the night hauls on the flats. The species resort to the shad spawning grounds to feed on the eggs, and must be enormously destructive in this way. On April 24, 1899, at Capehart's shad fishery at Avoca, not less than 5,000 white catfish, from 6 to 24 inches long, were caught at one evening haul, and these were without exception absolutely gorged with shad spawn, so that their bellies were distended like balloons. Schools of alewives are followed to their spawning grounds by droves of catfish, which feed on the eggs. The spawn of white perch, yellow perch, and other species is also extensively consumed by this catfish.

Forbes and Richardson say:

The charge of spawn-eating has frequently been preferred against this fish (*A. nebulosus*) as well as its near relatives, especially by the whitefish and shad culturists. The evidence for such a view is, however, scanty.

Under the heading "Salmon not injured by catfish," in the Bulletin of the United States Fish Commission, volume VII, 1887, page 56, Mr. Horace Dunn makes the statement:

Word has gone out that catfish have been taken in Suisun Bay [California] whose stomachs were full of young fish and salmon spawn. Upon this statement the cry has been made that the catfish were destroying both spawn and young salmon. The facts

of the case are that the catfish were caught in the vicinity of a salmon cannery, and that the spawn was among the fish offal thrown into the bay, and the young fish were "split-tails" and not valuable for food purposes.

The facts of the case as stated do not prove that catfish may not be injurious to salmon. The chances are that if they would eat salmon spawn as offal, and living "split-tails," they would eat naturally deposited spawn and young salmon of the "split-tail" size if they had access to them.

Smith says:^a

The catfish have a reputation among the California fishermen of being large consumers of fry and eggs of salmon, sturgeon, shad, and other fishes. This accords with their known habits in other waters. Mr. Alexander's examination, however, of the contents of several hundred stomachs of catfish in California and Oregon yielded only negative results as to the presence of young fish and ova. Writing of the bullhead in Clear Lake, California, Jordan and Gilbert say that it is extremely abundant and is destructive to the spawn of other species. The scarcity of the valuable Sacramento perch in that lake, which they attribute to the carp, here as in the Sacramento River, may be partly due to the more numerous catfish, which feed almost exclusively on animal matter.

BREEDING HABITS.

Probably less is actually known of the breeding habits of most of the species of catfishes than of their other habits, yet observations have been made upon two or more species with sufficient detail to warrant the assumption that in the main the habits of most species are essentially alike. Speaking of *Ictalurus punctatus*, Jordan says that it spawns in the spring, but that its breeding habits have not been studied. Mr. Jones (loc. cit.) says this species spawns when 1 year old, and twice a year—in May and in September. In the preceding spring he procured eight wild ones. After feeding them well up to this time (October 31), they had spawned in May and September and filled his pond. He says that they take care of their own young and trouble no other fish.

Ryder^b thus describes the breeding process of a pair of Potomac channel cats (*Ameiurus catus*) in the aquarium at Washington:

A number of adult individuals of *Ameiurus albidus* were brought from the Potomac River to the Armory building at the instance of Lieut. W. C. Babcock, U. S. Navy, and Colonel McDonald, and deposited in the large tank aquaria of that institution about the close of the shad-fishing season of 1883. One pair of these have since bred or spawned in confinement, and thus afforded the writer the opportunity of observing and describing some of the more interesting phases of the development of this singular and interesting family of fishes. * * * Its habits of spawning and care of the young are probably common to all the species of the genus, and are quite remarkable as will appear from the subjoined account.

On the morning of the 13th of July, a little after 10 o'clock, we noticed a mass of whitish eggs in one of our aquaria inhabited by three adult specimens of *Ameiurus albidus*,

^a Smith, H. M.: A review of the history and results of attempts to acclimatize fishes and other water animals in the Pacific States. Bull. U. S. Fish Commission, vol. xv, 1895, p. 387.

^b Ryder, John A.: Preliminary notice of the development and breeding habits of the Potomac catfish, *Ameiurus albidus* (Le Sueur) Gill. Bull. U. S. Fish Commission, vol. III, 1883, p. 225.

two of which were unmistakably the parents of the brood, for the reason that they did not permit the third one to approach near the mass of eggs, which one of them was watching vigilantly. One of the individuals remained constantly over the eggs, agitating the water over them with its anal, ventral, and pectoral fins. This one subsequently proved to be the male, not the female, as was at first supposed. The female, after the eggs were laid, seemed to take no further interest in them, the whole duty of renewing and forcing the water through the mass of adherent ova devolving upon the male, who was most assiduous in this duty until the young had escaped from the egg membranes. During all this time, or about a week, the male was never seen to abandon his post, nor did it seem that he much cared even afterwards to leave the scene where he had so faithfully labored to bring forth from the eggs the brood left in his charge by his apparently careless spouse. The male measured 15 inches in length, the female one-fourth inch more.

The mass of ova deposited by the female in a corner and at one end of the slate bottom of the aquarium measured about 8 inches in length and 4 inches in width, and was nowhere much over one-half to three-fourths of an inch in thickness. The ova were covered over with an adhesive, but not gelatinous, outer envelope, so that they were adherent to the bottom of the aquarium and to each other where their spherical surfaces came in contact, and consequently had intervening spaces for the free passage of water, such as would be found in a submerged pile of shot or other spherical bodies. It was evident that the male was forcing fresh water through this mass by hovering over it and vibrating the anal, ventral, and pectoral fins rapidly. There were probably 2,000 ova in the whole mass, as nearly as could be estimated. All of those left in the care of the male came out, while one-half of the mass which he had detached from the bottom of the aquarium on the third day, during some of his vigorous efforts at changing the water, were transferred to another aquarium, supplied with running water, and left to themselves. Those which were hatched by the artificial means just described did not come out as well as those under natural conditions. Nearly one-half failed to hatch, apparently because they were not agitated so as to force fresh water among them and kept clean by the attention of the male parent. * * * When first hatched, on the sixth to eighth day, the young exhibited a tendency to bank up or school together like young salmon. They also, like young salmon, tended to face or swim against the current in the aquarium, a habit common, in fact, to most young fishes recently hatched. * * *

On the fifteenth day after oviposture it was found that they would feed. While debating what we should provide for them, Mr. J. E. Brown threw some pieces of fresh liver into the aquarium, which they devoured with avidity. It was now evident that they were provided with teeth, as they would pull and tug at the fragments of liver with the most dogged perseverance and apparent ferocity. This experiment showed that the right kind of food had been supplied, and, as they have up to this time (August) been fed upon nothing else, without our losing a single one, nothing more seems to be required with which to feed them.

It is worthy of note that when pieces of liver were thrown into the aquarium the parent fishes would apparently often swallow them, with numbers of young ones eating at and hanging to the fragments. I was soon agreeably surprised to find that the parent fishes seemed to swallow only the meat, and that they invariably ejected the young fish from the mouth quite uninjured, the parent fish seeming to be able to discriminate instinctively, before deglutition occurred, between what were its proper food and what were its own young. As soon as the young began to feed they commenced to disperse through the water and all parts of the aquarium, and to manifest less desire to congregate in schools near the male, who also abated his habit of fanning the young with his fins, as was his wont during the early phases of development.

Regarding the breeding habits of *Ameiurus nebulosus*, Dean (loc. cit.) says:

In breeding habits the catfish still maintains its reputation for hardiness. It spawns rapidly, even when transferred to aquaria. The eggs are one-eighth inch in diameter and are adhesive, reminding one somewhat of frog spawn. The mass is deposited in shallows where the bottom is sufficiently hard to support its weight. The danger to the egg occasioned by stagnancy or muddiness of the water is carefully provided for; the male, standing guard, forces the water slowly through them. In some of the southern species, for thorough aeration, the male turns to account the operation of breathing, filling the back of the mouth often so full of eggs that the whole face and throat are distended. In the neighborhood of New York the spawning season is in the early part of April, and appears to last about a fortnight. Toward the latter part of the month the females go into deeper water. At this season (Central Park) of a dozen fish caught, ten proved to be males.

A similarity of breeding habits in *Ameiurus nebulosus* and *Ameiurus catus* is shown by comparing with the preceding record of Ryder the observations^a presented in a paper by Dr. H. M. Smith before the American Association for the Advancement of Science, and noticed^b in Science (Feb. 13, 1903, p. 243). Smith observed:

A pair of fish from the Potomac River in the Fish Commission aquarium at Washington made a nest on July 3,^c 1902, by removing in their mouths upward of a gallon of gravel from one end of the tank, leaving the slate bottom bare. On July 5 about 2,000 eggs, in four separate agglutinated clusters, were deposited between 10 and 11 a. m. on the scrupulously clean bottom. Ninety-nine per cent hatched in five days in a mean water temperature of 77° F. The young remained on the bottom in dense masses until 6 days old, when they began to swim, at first rising vertically a few inches and immediately falling back. By the end of the seventh day they were swimming actively, and most of them collected in a school just beneath the surface, where they remained for two days, afterwards scattering. They first ate finely ground liver on the sixth, and fed ravenously after the eighth day. The fish were 4 millimeters long when hatched, and grew rapidly, some being 18 millimeters long on the eleventh day, and at the end of two months their average length was 50 millimeters. Both parents were very zealous in caring for the eggs, keeping them agitated constantly by a gentle fanning motion of the lower fins. The most striking act in the care of the eggs was the sucking of the egg masses into the mouth and the blowing of them out with some force. The fanning and mouthing operations were continued with the fry until they swam freely, when the care of the young may be said to have ceased. During the first few days after hatching, the fry, banked in the corners of the tank, were at irregular intervals actively stirred by the barbels of the parents, usually the male. The predaceous feeding habits of the old fish gradually overcame the parental instinct; the tendency to suck the fry into their mouths continued, and the inclination to spit them out diminished, so that the number of young dwindled daily, and the 500 that had been left with their parents had completely disappeared in six weeks, although other food was liberally supplied.

In Sebago Lake, Maine, in a shallow, sandy pool, on July 6, the writer observed one catfish (*Ameiurus nebulosus*), sex undeter-

^a See also Eycleshymer, A. C., Observations on the breeding habits of *Ameiurus nebulosus*, American Naturalist, November, 1901, p. 911.

^b For the complete account see Smith, H. M., and Harron, L. G., Breeding habits of the yellow catfish. Bull. U. S. Fish Commission, vol. xxii, 1902, p. 151-154.

^c Italics by the writer to show close similarity to Ryder's observations.

mined, with a brood of young thickly clustering under it, in the manner previously described. From Smith's observations, they might have been 8 or 10 days old; from Ryder's, about 15 days of age. They were about 12 millimeters long. The development doubtless would be somewhat retarded in the cooler waters of this more northern latitude.

Forbes and Richardson describe the spawning habits of the "brown bullhead" (*A. nebulosus*) as follows:

The brown bullhead spawns in spring, the time having been May in 1898 at Havana (Craig). Their nests were found by Professor Birge in shallow bays with sandy bottom 6 inches to 2 feet deep. The eggs are laid in masses similar to those of the frog and are of a beautiful cream color.

Regarding the spawning habits of the "yellow bullhead" (*Ameiurus natalis*) Forbes and Richardson say:

The yellow bullhead spawned at Havana in May in 1898 (Craig). Females with ripe spawn were seen in the market at Meredosia on May 24, 1900 (large).

According to Smith, the spawning of the white catfish in North Carolina occurs in summer, and the spawning habits appear to be quite similar to those of the bullhead.^a

Regarding the spawning season of the blue catfish in Louisiana, Evermann says:

So far as the investigations of a single season may be relied upon, these results (referring to a table) indicate that the spawning season of the blue catfish in the Atchafalaya River is a prolonged one, but that the majority of the fish spawn in March and April.

Evermann states, regarding the goujon, that his investigation indicates that it has a somewhat later spawning season than the blue cat in the Atchafalaya River. Regarding the same species Forbes and Richardson state that, according to Havana fishermen, the spawning time in Illinois is in May or later.

FOOD QUALITIES.

In flavor and other edible qualities the catfishes differ somewhat among themselves. As a rule the channel cats, especially the spotted cat (*Ictalurus punctatus* and *I. furcatus*), seem to have a reputation for possessing more delectable qualities than the mud cats. This is possibly due to difference in habits and habitat.

Regarding *Ictalurus punctatus* Jordan says:

As a food fish the channel cat is certainly better worthy of attention than any other American catfish. There is much less waste in the body of the channel cat than in

^a There appears to be some evidence that the catfish identified by Ryder as the white catfish (*Ameiurus catus*) was possibly the bullhead (*Ameiurus nebulosus*). If such is the case, the similarity of habits previously described could be readily accounted for. The doubt thus arising indicates the necessity of observations upon the spawning habits of the white catfish.

other catfishes, as the latter lose more than half their weight by removal of the head, the entrails, and the skin. The flesh of the channel cat when fresh is very superior; it is white, crisp, and juicy, of excellent flavor, and not tough. It is much more delicate both in fiber and in flavor than that of the other catfishes. When well cooked, I consider it superior to that of the black bass, the wall-eye, the yellow perch, or any other percoid fishes. Among other fresh-water fishes it is inferior only to the whitefish, the trout, and other Salmonidæ.

Speaking of the blue cat (*Ictalurus furcatus*), Jordan and Evermann say:^a

In spite of popular prejudice to the contrary, the flesh of this catfish is of excellent quality, firm and flaky, of very delicious flavor, nutritious in a high degree, and always commanding a fair price.

Regarding the yellow cat or goujon, which they term the mud cat, the same authors state:^b

Its flesh is of fine texture and of excellent flavor, and there is really no good reason for the prejudice against it which obtains in many localities. The fact that it is a large, rather repulsive-looking fish, not too cleanly in its habits, doubtless has something to do with this.

And in the previously cited report Evermann writes regarding the same fish:

It is by no means a handsome fish; but its great size, the excellence of its flesh, and its superior keeping qualities render it a very important food fish.

Forbes and Richardson say that this species is commonly regarded as one of the very best catfishes for food, the flesh being of a fine texture and an excellent flavor.

Mr. Charles Hiester^c has written regarding *Ameiurus nebulosus* (?):

It is one of the very best of pan fishes and has no noticeable bones. It retains its excellence as fresh fish as long as any fish and longer than most of them. It is eaten and relished by all classes of people, and they would eat more if they could get them. It is not salted down, because the demand for fresh fish exceeds the supply. Its quality for table food will ever prevent its use for any other purpose.

The great popular demand testifies to the food virtues of the catfishes. By some persons the bullhead is preferred to the spotted cat and channel cat and by many it is considered their equal. It forms the fish part of the combination, "catfish and waffles," for which Philadelphia is famous.

Regarding the "yellow bullhead" (*A. natalis*) Forbes and Richardson say:

In the words of Doctor Jordan, these fishes are "small, but good eating," as we have ourselves proven.

^a Jordan, David Starr, and Evermann, Barton Warren: American food and game fishes, p. 19. (Doubleday, Page & Co., New York, 1902.)

^b Loc. cit., p. 32.

^c Letter in Bull. U. S. Fish Commission vol. II, 1882, p. 76-79.

MARKET FISHERIES.

STATISTICS.

Early statistics are so scattered and irregular in form, and even those covering any one of the recent years pertain to such a limited section of the country in that year, that it is difficult to make satisfactory comparisons to show the extent and growth of the market fisheries for catfish. Furthermore, no statistics are available for any section of the country covering a later date than 1905. Therefore figures for different sections for different terms of years must be used to demonstrate the extent, growth, and commercial importance of the fisheries, and these consequently convey only an approximate indication of the present conditions.

For many years the fishery for catfishes has been of considerable importance in certain previously mentioned sections of the country. The last census reports show that more catfish are caught and the value of the fishery greater than ever before. But both of these conditions are due to more extensive fishing, which in turn is accounted for by a greater demand and a wider market. A scrutiny of the figures for the sections of the country in which were located the principal fisheries of former years (the Great Lakes, the Gulf States, and the Middle Atlantic States) reveals that there is an actual falling off in their catch, the more recently established fisheries, in places that were formerly not extensively fished, accounting for the general increase. An exception is apparent in the South Atlantic States, but this probably "proves the rule," as the fishery has increased in extent in those states. There has been a great increase in prices per pound received by both fishermen and dealers in recent years.

Great Lakes.—Statistics of the fisheries of the Great Lakes in 1885 show 90,600 pounds of catfish and bullheads handled at South Chicago, for which the fishermen received \$764, an average price by the pound of less than 1 cent (0.84). The dealers are said to have received \$1,118, or an average price by the pound of about $1\frac{1}{4}$ cents (1.24).

In 1890 the catch of the Great Lakes amounted to 2,596,458 pounds, for which the fishermen received \$64,402, representing a price by the pound of nearly $2\frac{1}{2}$ cents (2.48). In 1903 the catch for the same waters is reported as 687,723 pounds, yielding to the fishermen \$25,847, or a pound value of $3\frac{3}{4}$ cents. There is thus shown a gain of about $1\frac{1}{4}$ cents for each pound of fish, but a total loss of \$38,555.

Gulf States.—In the Gulf States, exclusive of Florida and Alabama, the statistics show that in 1897 the fishery yielded 2,318,245 pounds, valued at \$45,932, to the fishermen, averaging nearly 2 cents (1.9) by the pound. In the same states in 1902 the catch amounted to

2,188,765 pounds, with a value of \$67,480, or an average price by the pound of a little over 3 cents (3.08). There is thus shown a falling off of 129,480 pounds in the catch, but the total value shows an increased gain to the fishermen of \$21,548.

The statistics of the Gulf States, including Florida and Alabama, for 1897, give a total catch of 2,448,564 pounds, valued at \$58,147, and for 1902 for the same states, 2,415,315 pounds, valued at \$72,991. These figures show a decrease of 33,249 pounds, but an increase in value of \$14,844 and an increase of nearly $\frac{2}{3}$ cent (0.65) by the pound.

South Atlantic States.—For this region, exclusive of Florida, the catch of 1887 is reported as 106,059 pounds, representing a value to the fishermen of \$2,844, or an average price by the pound of a little over $2\frac{2}{3}$ cents (2.68). In 1902 the catch in the same states is found to be 693,650 pounds, valued at \$18,824, or an average of a little less than $2\frac{3}{4}$ cents (2.71) by the pound. These figures indicate an increase of 587,591 pounds and in value \$15,980, without any great increase in the price by the pound. In the South Atlantic States, including Florida, there appears to have been from 1887 a steady growth of the fishery, a steadily increasing catch, and a corresponding increase in total value, but some fluctuation of the price by the pound.

STATISTICS OF THE CATFISH FISHERY IN THE SOUTH ATLANTIC STATES, INCLUDING FLORIDA, FOR CERTAIN YEARS.

Year.	Pounds.	Value.	Average price per pound.
			Cents.
1888.....	116, 126	\$2, 957	2. 54
1889.....	409, 794	14, 591	3. 56
1890.....	471, 208	15, 209	3. 22
1897.....	502, 311	11, 635	2. 31
1902.....	1, 310, 392	30, 976	2. 27

Middle Atlantic States.—The statistics for the Middle Atlantic States, exclusive of Virginia, show that in 1887 the fishery yielded 1,746,136 pounds, worth to the fishermen \$65,208, or an average price of nearly $3\frac{3}{4}$ cents (3.73) by the pound, and in 1904 a catch of 866,561 pounds, valued at \$40,756, or nearly $4\frac{3}{4}$ cents (4.70) a pound. There is here shown a falling off of 877,575 pounds and a decrease of total value to the fishermen of \$24,452, but an increase of nearly a cent (0.97) by the pound.

The available data for the Middle Atlantic States, including Virginia, go back only to 1890 and represent only four years. These four years show some fluctuations in amount and value of catch, as well as in price by the pound, but upon the whole a decrease in amount and total value, and an increase in price by the pound, as shown by the table on the following page.

STATISTICS OF THE CATFISH FISHERY IN THE MIDDLE ATLANTIC STATES FOR CERTAIN YEARS.

Year.	Pounds.	Value.	Average price per pound.
			<i>Cents.</i>
1890.....	2,758,711	\$100,253	3.63
1897.....	1,535,899	59,538	3.87
1901.....	2,063,584	77,396	3.65
1904.....	1,422,886	62,676	4.40

Interior waters.—The catfish fisheries in the lesser interior waters seem not to have been thoroughly canvassed prior to 1895. The data gathered in 1895 and 1896 covers 19 states for the year 1894. The states are Alabama, Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Nebraska, New York, Ohio, South Dakota, Tennessee, Vermont, West Virginia, and Wisconsin. The total quantity marketed was 14,726,812 pounds, valued at \$532,972 to the fishermen, or an average of nearly $3\frac{2}{3}$ cents (3.63) a pound.

The next comprehensive canvass was for the year 1899, when New York and Vermont were omitted. The total quantity that year is given as 7,648,179 pounds, with a value of \$339,800, about $4\frac{1}{2}$ cents (4.42) by the pound.

For the purpose of comparison New York and Vermont are here omitted from the 1894 data and the figures for the remaining 17 states give 14,576,545 pounds as the whole quantity marketed and \$526,194 as the total value, which indicates an average price by the pound of $3\frac{2}{3}$ cents. There is thus shown in five years in those 17 states a falling off in amount of 6,928,366 pounds marketed, and \$186,394 in value, but a gain of less than a cent (0.7) in the pound price. For only 11 of these states are sufficient recent data available to furnish a basis of comparison with the conditions in 1908. They are Alabama, Arkansas, Illinois, Indiana, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, and Wisconsin. The catches of these states in 1899 aggregate 6,316,403 pounds, valued at \$280,455, or nearly $4\frac{1}{2}$ cents (4.45) a pound. The yield of the same states in 1908, according to the preliminary reports of the census office, was 10,775,400 pounds, representing a value of \$459,830, or about $4\frac{1}{4}$ cents (4.26) a pound. These figures show that in nine years there was an increase of 4,458,997 pounds of marketed catfish, with a gain of \$179,375 to the fishermen, but a decrease in the price by the pound of nearly $\frac{1}{5}$ of a cent (0.19).

Summary.—The latest figures of the Bureau of Fisheries, of dates varying from 1902 to 1905 for the different sections of the country, give a total catch of catfish, including bullheads, as 12,718,003

pounds, with a value of \$531,529 and a price by the pound of nearly $4\frac{1}{2}$ cents (4.18). The census returns for 1908 give for the United States, exclusive of Alaska (where there are no catfish), 18,386,900 pounds, valued at \$792,830, which indicates an average price by the pound of nearly $4\frac{1}{2}$ cents (4.31). These figures indicate an increased catch since the last previous figures for the respective sections of 5,667,897 pounds, with an increased value of \$26,130 and an increase of price by the pound of only about $\frac{1}{8}$ of a cent (0.13). The calculations, however, are for obvious reasons not entirely satisfactory.

FISHERY METHODS.

The principal methods of the catfish fishery vary somewhat in the different localities owing to the difference in the conditions. It is doubtless a fact that the catches of some of the apparatus credited with catfish in many of the states are incidental, as suggested by the great disparity in the quantity. But from the statistics it is not possible in every instance to decide which, if any, are used exclusively or principally for catfish. It is reasonable, however, to assume that the apparatus that takes the largest amount is the principal one employed.

Great Lakes.—The fishery in the Great Lakes varies more or less in its methods in the different lakes. According to the report of the Commissioner of Fisheries for 1903, the small fishery in Lake Superior was by fyke nets only. In Lake Michigan pound nets, fyke nets, and seines were used. In Lake Huron pound nets, trap nets, gill nets, fyke nets, seines, and lines were employed. The largest catch was by pound nets, and was nearly twice that of the next in order, the trap nets. The smallest catch was by seines. In Lake Erie pound nets, trap nets, gill nets, fyke nets, seines, and lines were employed. The largest catch was by pound nets, the lowest by lines.

The line fishery in early years seems to have been, at least locally, more important. The Bureau of Fisheries report upon the Great Lakes in 1885 makes the following statement under the heading of "Catfish hooking around the islands:"

A large number of men and boys on the islands take catfish with set lines in 15 to 30 feet of water, between June and September, or, in some localities, from May 15 till late in October. Some of them are professional fishermen, while others are farmers living along the coast. There are two varieties of catfish caught, known to the fishermen as blue or black catfish and yellow catfish. The blue species varies in weight from one-half pound to 40 pounds, but generally weighs between 5 and 15 pounds. The yellow fish weigh from 4 to 6 pounds, or, in occasional instances, 8 or 10 pounds. The fishermen consider the yellow variety more palatable than the blue, though they have the same price in the market. The catfish caught in the pound nets in the spring and fall are shipped in the "rough" or undressed state to the dealers, who have them dressed before supplying them to the retail trade; but those taken in summer with hook and line are dressed by the fishermen, though about half of their weight is lost in the process. This species is always in demand and brings a good price.

In Lake Ontario the same apparatus was used as in the other lakes, excepting that no catfish were recorded for gill nets and lines.

Middle Atlantic States.—The most recent available data here, for 1904, show that in New Jersey by far the largest quantity of catfish were taken in seines, although some were taken in pound nets.

In Pennsylvania, while seines and fish baskets were also used, fyke nets yielded the largest catch.

In Delaware, while fairly large catches are recorded for gill nets, pound nets, and seines, the fyke nets far exceed them in amount. The same is the case in Maryland. Here, however, there is recorded a small line catch.

The apparatus listed for Virginia comprises pound nets, seines, lines, gill nets, fyke nets, weirs, and slat traps, of which fyke nets, closely followed by pound nets, were most effective.

South Atlantic States.—In 1902 it was found that gill nets, pound nets, fyke nets, catch wheels, slides, and lines were used in North Carolina, pound nets yielding the largest and lines the smallest catch.

The only apparatus used in South Carolina that appears to have taken any catfish is the seine.

In Georgia catfish were taken by pound nets and lines only, the lines yielding about twice the amount of the other. It is probable that here the line fishery is the special one for catfish, and the pound-net catch more or less incidental.

In east Florida but three methods seem to have been used in the fishery—seines, pound nets, and lines. Here, however, the seine records the greatest catch, followed by the line, the pound net yielding the smallest quantity.

Gulf States.—In this region, according to data for 1902, trap nets took the largest catch in western Florida, only one other method, the line, being employed.

In Alabama trammel nets, seines, and lines are credited with catches of catfish. The first far exceeded the other two together, while in Mississippi the same apparatus was used, but the line fishery more than quadrupled the other two together.

In Mississippi seines, fyke nets, and lines are listed as apparatus that took catfish, of which the line fishery more than fourteen times exceeds the other two combined.

The report on the Mississippi River and its tributaries for 1899 credits catfish to fyke nets, lines, and spears in Indiana, of which fyke nets were the most effective. In Illinois seines, trammel nets, fyke nets, pound nets, set lines, drift lines, hand lines, and traps were listed, of which set lines are credited with the largest catch, closely followed by seines and fyke nets. Kentucky is recorded as using seines, fyke nets, trammel nets, cast nets, dip nets, set lines, hand lines, and drift lines, set lines yielding the largest catch and fyke nets a close second.

Tennessee is listed with seines, fyke nets, trammel nets, lines, and trap nets, of which lines are credited with the largest catch and fyke nets follow closely.

Only three methods—set lines, fyke nets, and wooden traps—are mentioned for Alabama, of which the catch of the latter greatly preponderated.

In Mississippi seines, trammel nets, fyke nets, pound nets, drift lines, and set lines were all credited with catfish, but set lines took more than six times as many as all the others together.

For Louisiana lines, seines, fyke nets, wooden traps, and trammel nets are mentioned. Lines took the largest quantity and fyke nets next.

Evermann^a gives an interesting account of the methods employed in the catfish industry of the Atchafalaya River in Louisiana.

The Atchafalaya River is in some respects a peculiar stream. It has its sources in Avoyelles and Point Coupee parishes, near where the Red River joins the Mississippi, and is at all seasons more or less connected with both of those rivers by a number of anastomosing channels and bayous. The Atchafalaya River is, in fact as well as historically, one of the mouths of the Mississippi River, and during the floods which come periodically to that region a vast amount of the surplus water of the Mississippi and Red rivers is carried to the Gulf by the Atchafalaya. * * * There are four species of commercial catfishes handled by the firms at Morgan City and Melville, viz: The blue cat or poisson bleu (*Ictalurus furcatus*), the yellow cat or goujon (*Leptops olivaris*), the eel cat (*Ictalurus anguilla*), and the spotted cat (*Ictalurus punctatus*). * * * All river fishing during the fall and winter is done on the bottom, while all lake fishing is at the surface. During the spring, when the country is flooded, the fish betake themselves to the woods, and the fishing is then carried on chiefly along the edges of the float roads. The old tackle, which had been previously used in rivers and lakes, is now cut up into short lengths and tied as single lines, called brush lines, to the limbs of trees in such a way as to allow the single hooks to hang about 6 inches under the water. Each fisherman ties his lines to the trees along the edges of the float roads, if he can find such territory not already preempted by some one else.

Interior waters.—The Arkansas list of apparatus comprises seines, trammel nets, pound nets, fyke nets, set lines, miscellaneous lines, and dragnets. Set lines are credited with the greatest amount, fyke nets are second, and seines third. Set lines, seines, fyke nets, pound nets, and trammel nets were employed in Iowa, the fyke nets far exceeding the others in the amount of the catch.

Wisconsin is listed with set lines, seines, fyke nets, shut-off nets, and trammel nets. Set lines were here shown to have yielded the largest catch. Trammel nets were credited with an exceedingly small amount.

Seines, trammel nets, fyke nets, pound nets, hand lines, drift lines, trap nets, and baskets comprised the apparatus used in Missouri. Fyke nets were credited with the largest catch, followed by seines.

^a Evermann, B. W.: Report on investigations by the U. S. Fish Commission in Mississippi, Louisiana, and Texas, in 1897. Report U. S. Fish Commission, 1898, p. 290.

In Minnesota hand lines, set lines, seines, fyke nets, pound nets, and trammel nets were used. Set lines, closely followed by hand lines, far exceeded the others in amount of catch.

In South Dakota the catch of set lines, with fyke nets as a close second, greatly exceeded the others in amount.

In Nebraska set lines exceed the others in catch. The fyke net is not far behind. The yield of the other two, i. e., seines and trammel nets, are far below them.

In Kansas seines, fyke nets, set lines, and trammel nets were used. Set lines were the most effective, fyke nets next; the others far behind.

CULTIVATION OF CATFISHES.

In the work of the Bureau of Fisheries the best results in catfish culture have been obtained with the bullhead, or horned pout (*Ameiurus nebulosus*), called also yellow cat in some localities. This species lends itself readily to pond culture, and is being successfully produced at stations in the Southern States devoted to the basses and other pond fishes. A manuscript report by Mr. J. J. Stranahan, superintendent of the United States Fisheries station at Cold Springs, Ga., containing observations regarding the breeding habits of the bullhead and the methods of cultivating this fish at that station, is printed in full herewith.

NOTES ON CATFISH AND CATFISH CULTURE AT COLD SPRINGS, GA.

By J. J. STRANAHAN.

Realizing that there is a growing interest in the catfish among the planters of the South and that the combination of bream and catfish is the best for ponds of small area, especially for those who want the fish for food rather than for show or sport, the writer determined early in the season to make a study of the breeding habits of the marbled catfish, *A. nebulosus*, the species hatched at this station, with a view of producing them in greater numbers than has been possible in the past.

So far as our experience goes, and it has extended over twenty-five years in both the North and South, there is but one species of catfish that is really desirable for pond culture, especially if the area of water is restricted, and that is *A. nebulosus*, or what is usually known as the bullhead or horned pout and marble catfish in the North (although all of the small catfishes are called bullheads in the North) and speckled catfish in the South. All attempts, so far as we know, to domesticate and successfully rear the channel cat (*Ictalurus punctatus*) in small areas of water have utterly failed.

The people of the whole country, and especially of the central South, regard the catfishes favorably, and the interest in them is surely growing. This being true, it follows that an effort should be made to produce them in greater numbers than has been done in the past.

After observing results for several years it seems clear to us that the catfish under consideration (*A. nebulosus*) does better in wild ponds, even of small area, than in those that have been established with much care and pains.

It has been noted at this station, especially in pond M, where conditions are favorable, that the catfish like some such cover as a sunken log or stump. Accordingly it was

determined to place sunken boards in the ponds where these fish are kept, in such numbers that each individual fish should have a home of his own as well as a nesting place. The water in the ponds was drawn to near the bottom and inch boards 12 inches wide and 5 or 6 feet long were used, one end being driven into the embankment a few inches, the other end being fastened to the bottom by driving a 1 by 3 inch stake down at the end and nailing through this into the board. In most cases this left an opening under the center of the board, but where it did not the catfish very soon dug out the earth and made the place to suit themselves. In fact, the writer would recommend that this feature be left to the fish, for it was observed that they dug out the earth and occupied these boards, which were flat on the bottom, before they did the ones along the embankments where an opening was all ready for them. We shall also in future use a board about 3 feet long, as that proves ample for the needs of the fish, requires less lumber, and is less in the way during seining operations. The board should also be well tramped down into the mud so that the stakes will not hang the seine, the stake and board being a little below the general level of the bottom of the pond. If put in thus, it might be well to make the beginning of a depression under the board with a shovel or mattock, as otherwise the board might be overlooked by the fish. This, however, is not likely.

I would here make a special note, special because I believe that it is important in the production of bullheads in numbers. Although the fish ordinarily use the boards in spawning, it was noted that early in the season while the water was yet cool they did not use these, but resorted to the shallows of the ponds where the water is about a foot deep and there established their beds, making a depression in the mud and weeds shaped like a track made by a moccasin-covered foot, the depression being about 18 inches long and 6 wide at the broader end. The parent fish, with their heads to the broader end of the depression, here deposit the eggs. We had no boards in water less than 2 feet in depth, but by accident one board was left on the embankment with one end in the pond in about 6 inches of water. This was early occupied by a pair of catfish and a large brood produced.

All this demonstrates that to be most effective a portion of the boards should be in the shallow water for the use of early spawners. It also strongly suggests that the flow of water into the pond should be so regulated as to produce the highest temperatures attainable in the early part of the season. In the morning the supply should be reduced or cut off entirely, while at night, when the water may be warmer than the air, it should be turned on in full supply.

In this connection I would recommend that where practicable water for the supply of catfish ponds would best be taken from some other pond, so that a higher temperature may be maintained, especially early in the season and during periods of low atmospheric temperature. We have about 32 or 33 catfish in each of our ponds K and M, the former being of about twice the area of the latter. K is supplied direct from the springs, M from a 2-inch iron pipe from pond L, one of our largest and warmest ponds. The catfish hatch has been more than double in M what it has been in K and, for all we know, one pond is as favorable for the fish as the other, both having muddy bottoms and an abundance of vegetable growth. We believe that the temperature of the two ponds is responsible for the difference. As soon as the weather grew hot all of the beds were placed under boards in 2 or 3 feet of water and not one in the shallows.

This matter of temperature may account for the unfavorable results some seasons when practically no catfish are hatched in even the wild ponds, and other conditions than temperature may also have a controlling influence. It is probable that muddy water would be unfavorable and even low atmospheric pressure also, fishes being more susceptible to changes of pressure than air-breathing animals.

From the start we have watched the developments in our catfish ponds K and M. The first point of special note is that the fish were seen spawning about a month earlier than usual, although it must be admitted that a much closer watch was kept (daily,

almost hourly) than ever before. It has been suggested that possibly the contentment brought by the homes afforded by the boards may have had some influence in favoring reproduction. At all events our hatch has been more successful than for the past six or seven years, and we know of no other cause to ascribe it to.

Our first surprise was at the short period of incubation of the eggs. Based on temperature and the period of other fishes, the time should have been about 24 to 30 hours, but these catfish eggs hatched in less than 20 hours. How much less we do not know, but every effort to find out positively will be made during the remainder of this season and next. In the two cases observed so far this season we were thwarted in getting the exact time by the fish coming off unexpectedly early in the morning or in the night. The temperature of the water at the beds in both cases under observation was $77\frac{1}{2}^{\circ}$ to $78\frac{1}{2}^{\circ}$ F., varying with the time of day.

The first case closely watched was on May 8, when at 9.30 a. m. a female catfish was seen in a depression, such as previously described, in about 12 inches of water and 3 feet from shore, in fine position for close observation. She was over a quantity of light-orange-colored eggs, forming a gelatinous mass about 4 inches wide and 5 long and apparently three-fourths of an inch thick or deep. They had every appearance of being freshly deposited, the water still being somewhat muddy owing to the digging of the depression. The male was lying some 3 feet away with apparent unconcern. At 7.30 the next morning both fish and eggs were gone from this spot, but lying some 10 feet away was a female with a brood of very small young, the male being near by and the fry inactive, as they invariably are when just hatched. These adult fish had every appearance of the ones observed the day before.

The second and last case observed was a better one than the former for reasons that will be obvious to the reader. On May 13 at 9.30 a. m. the writer discovered a pair of catfish in a depression, as before described, in about 1 foot of water and 6 feet from shore. The fish were lying side by side, about an inch apart and apparently inactive. There were no tremors or other evidence of an orgasm, so apparent in the case of black bass and other fishes in the act of depositing spawn and impregnating it, and there were no eggs visible on the bed, although the mud on the bottom between the fish and at each side of them could be plainly seen. After a little less than an hour, during which, unavoidably, watch was kept for only about fifteen minutes, the male was found off the nest a short distance away and the female in the center of the bed over a bunch of eggs such as is described in the former case. It is regrettable that continual watch was not kept, and a further shortcoming in observation is also to be deplored. At 7.30 the next morning the fish and the eggs were gone and, as in the former case, the female with a brood and the male standing guard were some 10 or 12 feet from the vacated bed. In the former case the writer assumed that the eggs had been deposited a few hours before discovered and that at least 24 hours would be required for hatching. This led in the second case to a reckoning on his part that the eggs would not be hatched when he went on duty at 7.30 a. m., an error which will have to be corrected by further observation. This is the more a pity, as the opportunity was good for determining the exact period of incubation with this fish in a given temperature of water.

It should be stated that this last lot of eggs was watched from time to time during the day and that but little change was noted. Late in the afternoon, almost sundown, it was thought that the egg mass was somewhat darker, especially around the edges.

During these observations we have arrived at the conclusion that the female of this species broods the eggs during incubation and cares for the young after they are hatched, the male remaining near by in either case and acting apparently as a guard. This opinion as to the division of parental duties is based on the fact that it is the larger fish that broods the eggs and cares for the young, the smaller one standing guard and that, without a single exception in our observations of several broods, the smaller, or guard fish, has an ugly wound on the top of his head well back of the eyes, where the teeth of

his antagonist would come when the jaws of the two are locked, head on, in their fights for the possession of the females. This is the opinion of the commercial fishermen at Chautauqua Lake, New York, where many male fish are found locked together, dead or dying, during the breeding season. We have observed no deaths from this cause, and the fact that all fish that we call guards are wounded as described would seem to indicate that they lock and then break away and lock again, thus giving each combatant a chance to have a sore head.

As with the black bass, and doubtless many other fishes, there is as much difference in these female catfish on the point of being good or poor mothers as there is in the case of hens or human beings. One mother will be seen working continually stirring up the mud to procure food for the fry, rounding them up when a portion of the brood wanders away and keeping the school together until they have grown to an inch and a half in length and are as large around as a lead pencil, while another fish, probably of the same age and size, will leave her young to stir up the mud for themselves, allow them to break up into small schools, and finally will abandon them entirely. They then wander about in small bands or are incorporated with some other brood.

Another very interesting feature in the breeding habits of this fish is that schools of about the same age, or, say, within a week of each other, coalesce, all in the pond forming into one school. In ponds K and M there were several early broods in each pond. These remained with their respective parents until they had attained some size and become active in their search for food, when they consolidated into one large school in each pond and so remained until collected for shipment. The ponds were so clear and the black mass of moving fry so easily seen that there was no doubt about the correctness of this observation. The later hatches remained with their parent fish, not joining with the older broods, but subsequently they sought other broods of about their own age, thus again forming another large school.

Some experiments have been made in feeding these small catfish, with a view to holding them in fry ponds, all former attempts in this direction having failed. Well-cooked corn mush thinned down to a gruel was distributed in a narrow line along the margin on one whole side of a pond, and at the termination of the trail a considerable field, say, 8 or 10 feet square, was moderately covered with the feed. The fragmentary schools—those broken up through poor maternity or other causes—would strike these trails, follow them as a hound would follow a rabbit track, and then clean up all of the feed on the field referred to. They also greedily devour finely ground mullet. It is believed by the writer that excellent results may be attained through a judicious system of feeding both the old and young of this species. As the adults are not pugnacious, except the males during breeding season, we believe that 100 adults could easily and successfully be carried in each of our ponds by giving each a board home and supplying them a suitable quantity, with some variety, of proper food—say cut mullet, with liver for a change. These fish are not subject to epidemics, are easily raised in ponds, finding much of their own food, and are easily captured when wanted.

Mr. W. E. Meehan, Commissioner of Fisheries for Pennsylvania, has found (see Transactions of the American Fishery Society, 1908) that for the "white" and "yellow" catfish an ordinary pond 100 feet square or larger will breed the fish. It should have "heavy" hard clay banks so that the fish when ready to spawn may dig a hole in the bank that will not cave in. The water should also be "cloudy." When the little fish have arrived at the "advanced-fry" stage, they leave the nest or hole and begin "rolling," as it is called. The large fish circle round and round and move the fry over the pond in the form of a ball-like mass. When these balls begin to break up, the fry are

gathered by means of a net and put into a vacant pond, where they are fed and held for shipment as fingerlings. According to Mr. Meehan the adults do not require a great flow of water; but in order to keep them healthy they must be liberally fed, not only through summer, fall, and spring, but during the winter. The manner of feeding in the winter is to cut a hole through the ice and sink to within a foot of the bottom a wire basket filled with cut liver. The catfish feed therefrom very readily and emerge in the spring fine and plump and in good condition for spawning.

It is evident from the foregoing notes, and from general experience, that the common bullhead or hornpout is easily bred and reared in small ponds and is the catfish best suited to meet the demands of private pond owners, farmers, and the public generally. A few fish will soon stock a pond, and with a reasonable amount of care and favorable conditions will furnish a supply of excellent food fish for home and even for market purposes.

At the government stations the cultivation of the bullhead, while easily successful, has not been undertaken on a very large scale for lack of sufficient pond space, other branches of the work demanding greater attention. The bullheads hatched have, however, been reared to fingerling size and larger before planting, and the number so produced—13,725 in 1909—may therefore be regarded as considerable. Recommendations now before Congress, if adopted, will provide a new station for the primary purpose of catfish culture.

SPOTTED CATFISH.

With the spotted catfish (*Ictalurus punctatus*), the attempts at pond culture by the United States fishery stations and the state commissions are so far negative. Observations as to the spawning habits of this species have proved difficult to make and are as yet inadequate to afford proper knowledge upon which to proceed. Experiment has shown that the spotted catfish will not thrive in the still, muddy waters that seem to be suited to the bullhead, and such facts as have been gathered regarding its natural history indicate that it requires clearer, moving water. Both the spotted cat and the blue channel cat (*Ictalurus furcatus*) are found in the San Marcos and Blanco rivers, Texas, usually in swift water over gravel or sand shoals, and Mr. John L. Leary, superintendent of the United States Fisheries station at San Marcos, thinks that they probably spawn in those rapid places, though he has never actually observed them on their spawning beds. It would seem that "quick water" is not always necessary, however, for the spotted cat abounds, or did abound a few years ago, in the St. Johns River, Florida, where there are no riffles or rapids whatever. Here the localities where the water

is clear, comparatively cool, and flowing with a steady, moderate current, over sandy or rocky bottom, perhaps afford spawning grounds for the spotted cat. The Bureau is continuing its efforts to learn the facts as to the conditions required by this fish and expects in time to propagate it successfully.

FISH-CULTURAL DISTRIBUTIONS AND RESULTS OF PLANTS.

The greater part of the Government's supply of young catfishes for distribution is derived from overflowed bottoms in the Mississippi basin. Young fish of all kinds are left in the sloughs when the waters have receded, and among these are found spotted cat, black cat, marbled cat, and bullhead, which, with black bass, crappie, perch, and other species, are seined out annually in large quantities by the Bureau of Fisheries and, except those restored to the river, are used to augment the stock of the hatcheries for distribution to applicants. The number of catfishes so collected runs into hundreds of thousands each year, and in 1909, with the young bullheads hatched at the stations, brought the total distributions of catfish to 562,580.

The increasing popularity of the catfishes appears to some extent in the growing number of requests for them received by the Bureau of Fisheries. These requests come from practically every state and territory, but, as already stated, the catfishes are best known and appreciated in the South and Middle West. The following letter, published in the Bulletin of the United States Fish Commission, volume IV, 1884, page 321, may be quoted as showing an early successful attempt to cultivate the "speckled catfish" in Georgia:

It is naturally a pond fish, and found only in one locality in the South, at least such is my information and observation. That locality is in Flint River, running south and emptying into the Chattahoochee some distance below Columbus, Ga. Many years ago this fish was plentiful, being found only in still water, lagoons, or ponds. The Flint River runs through the Pine Mountain. Not far south or north of the mountain these fish cease to occupy the waters and inhabit only the tributaries to the rivers, including a space of about 50 or 75 miles. Some time since I determined to try to domesticate them, and the effort has resulted in success. * * * They love a pond of clean water and a mud bottom. All the floods that come can not wash them from their home, unless the whole of the pond is carried away. They will not go into running water if they can avoid it. Disturb them and, like a carp, they will sink in the mud and hide. They can be caught conveniently in a gill net, but with great difficulty in a seine. My pond covers 5 acres of land, the largest and best pond in western Georgia. It is a perfect mass of fish, and has been constructed only eleven months. The water is from an inch to 5 feet deep and abounds in vegetation.

In a number of letters in answer to inquiries, recipients of catfish distributed by the Bureau of Fisheries report their experience with and the results of the plants. Those that refer to the "speckled catfish" mean perhaps, in some cases at least, the bullhead (*Ameiurus nebulosus*), which, as Mr. Stranahan has pointed out, is called "speckled catfish" in the South. But the size attained in some

instances by the speckled catfish, according to the report, casts a shadow of doubt over those particular cases. Others undoubtedly refer to the spotted catfish. The most satisfactory results appear to have been reached with the "speckled cat."

It may be of interest to quote from some of these letters.

A letter received February 4, 1907, from Lumpkin, Ga., says regarding fish sent out in 1903 (?):

The fish received was the spotted catfish. They were put in a pond of about 2½ acres and from 1 to 8 feet deep. The fish that survived grew and did well. They did not thrive [multiply?] well on account of turtles. The water was from a clear branch but ran through hilly lands and was constantly muddy on account of rains. I did not give the pond the necessary attention, yet there was a nice lot of fish caught from it. There were in the pond also what is known here as a mud cat, not a very desirable fish. I thought that perhaps they preyed on the others when small. Upon the whole I think they were adapted to the water and would have done better if I had drawn the pond and cleared it of turtles, mud cats, etc. But the pond was a railroad fill, and I could not draw it off. Yet for the chance they had I believe the fish did very well, and had I been able to clean out the pond I could have made it a success.

From Pomona, Ga., regarding fish that were planted in a pond at that place:

I have seen very few of the speckled catfish in the past two years although I have watched for them, and am inclined to think they have been destroyed by black bass. I have caught quite a number of the old ones during the past year, weighing from 1 to 2 pounds.

From Sparta, Ga., a letter received December 2, 1907, replies regarding 1903 (?) fish placed in a pond:

The speckled catfish seem to increase very fast—faster than any other fish in the pond. Am well pleased with them.

An enthusiastic letter dated January 3, 1908, was received from Heard, Ala., regarding fish planted in a pond in that vicinity:

In reply to your inquiry regarding the speckled catfish: There has been a wonderful growth of them and it seems as though my pond is a fine place for them. I have fish to eat all through the fishing season. I have not stocked my pond with any other kinds, but others, such as warmouth perch and mud catfish, have come in.

In 1905 I saw a school of young speckled catfish in my pond, the growth of which was surprising to behold. I feed my fish with bread, scraps of beef, and pulp, and catch them in a basket that I use to feed them in. I caught in one basket at one time 14 pounds of speckled catfish. I am doing everything in my power to get my neighbors to build ponds and raise their own fish at home with a very small cost to them. I consider that my pond has paid me well for time and expense. The bottom of the pond is of moss and sand and there is a pure, never failing stream. In some places the water is 10 feet deep, with lots of moss, grass and cat-tails growing in it.

Another letter from Georgia, dated February 1, 1908, says:

In reply to your inquiry, I beg to say that the speckled catfish received of you in 1902 have succeeded beyond my expectations. I had them placed in a small artificial pond supplied entirely by spring water, and, with virtually no care, they have multiplied rapidly and grown wonderfully under the circumstances.

I consider the speckled catfish by far the best variety of fish for small ponds to be obtained, as they are thrifty growers, with a flavor equal to any.

A letter dated February 11, 1908, from Washington, Ga., states:

In answer to yours of February 2, I state that I am well pleased with the results from planting catfish in Armstrong Pond or Lake. When conditions are favorable we often catch a string of nice fish, a yard or more in length, in a short time. I do not think the speckled cat can be excelled for eating unless by such fish as trout or white perch. * * * I placed 40 or 50 in several small creeks near by and from these streams we now catch, very often, a good supply of speckled catfish, the descendants of the same fish your department sent me. They thrive well here and their introduction is a blessing.

A letter from Atlanta, Ga., dated February 1, 1908, tersely says in part:

Catfish did fine; largest weighed $2\frac{1}{4}$ pounds; exceedingly prolific; satisfaction perfect; March, 1907, lost dam on account of long continued rains.

From Columbus, Ga., February 1, 1908:

The speckled catfish were placed in my mill pond very successfully in 1903. I watched them with a good deal of interest and had them taken care of. I did not allow any fishing done in the place until last year, but found that it was almost impossible to catch any of the fish although we could see a great many in the pond. Unfortunately about thirty days ago a heavy rain broke my milldam, and I am very much afraid that some of my fish got away; however, I hope not many. * * * These fish were placed in a mill pond the water of which is furnished by a clear creek stream.

Regarding fish planted in his private pond a resident of Fort Deposit, Ala., under date of February 4, 1908, writes:

Replying to your circular letter of December 2, 1907, will say that the fish in my pond have done well. They have increased in numbers and have grown considerably. The pond is of clear pond water coming from wet-weather springs and seep from the soil.

A letter from Americus, Ga., received February 4, 1908, expresses satisfaction with the fish sent, saying, in part:

I consider the fish a success. They did well and increased very fast.

From Lizella, Ga., in a letter dated February 5, 1908, regarding "spotted" catfish placed in a mill pond:

As to the spotted catfish, they did fine. I think I have caught several of 3 pounds weight each.

The following letters relate to catfish planted during the fiscal year of 1904.

From Sunnyside, Ga., in a letter dated January 18, 1909:

The speckled catfish that were planted in Malaires pond grew nicely until large enough to bite a hook, then most of them were caught by negroes who fish the pond incessantly with hooks. While of course there are, we suppose, a few left we do not know how many. I have planted no other fish in this pond. I think that several years previous to this plant some one else planted black bass and it is my opinion that these bass destroyed a lot of these catfish.

A letter from Columbus, Ga., dated January 18, 1909, says:

With reference to speckled catfish in Lake Mahignac, I beg to advise that the results were very good. We are catching some of them with hook and line that will weigh from 3 to 4 pounds, others smaller.

Lexington, Ky., January 23, 1909:

The fish sent me grew very well. The third year they ran from 3 to 5 pounds. They never increased [in numbers] that we know of. * * * I think the spotted catfish is better adapted to running streams. We find plenty of them in Kentucky River. I also think they do well in reservoirs.

Regarding a consignment of "speckled catfish" planted in private fish ponds, a letter from The Rock, Ga., received January 22, 1909, states:

The speckled catfish were planted on arrival. They spawned the next season and hatched all right, but do not seem to grow and thrive as they should. It may be that they are not fed on the right kind of food. They are fed usually on cooked corn bread. If they need other food, I do not know what it is.

From Alva, Okla., under date of January 27, 1909:

The fish planted in Little Driftwood Lake in 1903 have multiplied until now there are great numbers of them. Three and a half pounds is the largest we have taken out. I also have many sunfish, blue cat, and bullhead cat. This lake supplies us with all the fish we want. We allow many of our neighbors to fish with rod and line, as the fish seem to increase faster than we can use them.

From Hampton, Ga., January 30, 1909:

We put the catfish in a pond with just ordinary branch-water supply. They did well and have made quite an increase, at least quite a number have been caught annually from the pond and still it is well supplied with the same kind of fish.

A note written on the returned circular of inquiry, from Walnut Cove, N. C., January 30, 1909, regarding the fish planted in a farm pond, states that the old fish are about 18 inches long and that there have been young fish for the past two years.

A note dated February 13, 1909, regarding fish planted in Lake Pippin, near Akron, Ohio, states they thrived and multiplied greatly, and that it can be said without fear of contradiction that there is not a nicer body of water or a better stocked lake within the state.

INTRODUCTION OF CATFISH INTO PACIFIC STATES.

Dr. H. M. Smith has exhaustively covered this subject up to 1895.^a He states that three species of catfish—the white catfish (*Ameiurus catus*), the yellow catfish or bullhead (*Ameiurus nebulosus*), and the spotted catfish (*Ictalurus punctatus*)—inhabiting parts of the United States east of the Rocky Mountains, have been transplanted to the Pacific States. The first introduction was in 1874 and consisted of

^a Smith, H. M.: A review of the history and results of the attempts to acclimatize fish and other water animals in the Pacific States. Bull. U. S. Fish Commission, vol. xv, 1895 (1896), p. 379-472.

56 large Schuylkill catfish (*Ameiurus catus*) from the Raritan River, New Jersey, and 70 hornpouts or bullheads (*A. nebulosus*) from Lake Champlain, Vermont. The first were deposited in the San Joaquin River, near Stockton, Cal., and the bullheads were placed in ponds and sloughs near Sutterville, Sacramento County, Cal. Other consignments of a few spotted catfish have since been sent to California, amounting in all to 510. From the waters thus stocked by the United States Fish Commission the California Fish Commission distributed the various catfishes widely in that state.

In 1877 the State Fish Commissioner of Nevada transferred from the Sacramento River a large number of the "Schuylkill cat" (*Ameiurus catus*), and with these and their progeny as a basis of supply, the fish were widely distributed in Nevada waters.

Up to 1908, 710 catfish had been sent to Oregon and 2,175 to Washington. It is evident that they found these new waters peculiarly suited to them, as they multiplied prodigiously and grew rapidly. It was not long after the first plants were made that a catfish fishery was inaugurated. Smith says:

The practice of taking these fish for market from public waters has probably increased from year to year, although no statistics are available for any early years. At present it is probable that more catfish are caught for local and home consumption than for sale in the large marketing centers, but no accurate idea of the extent of the desultory and semiprofessional fishing can be formed.

The catfish fishery is not of large proportions in either California or Oregon. Only a small amount of capital is invested in it, but few persons are regularly engaged, and the catch is insignificant compared with the yield of many other fish taken in the same waters. The industry is more extensive in California than in Oregon.

The commercial fishery, in California at least, has probably reached its height, if it is not already on the decline. The receipts of catfish by the San Francisco dealers in 1894 were nearly 30 per cent less than in 1893; the decrease was due wholly to the lack of demand, the fish being more abundant.

The estimated amount of catfish caught in California in 1893 totaled 200,000 pounds, making a gross value of the fish to the state of \$8,500. (Smith, p. 391.)

Regarding the catfish trade, Smith goes on to say:

The principal marketing centers for catfish are San Francisco, Sacramento, Stockton, and Portland. The last-named place has the most extensive trade. In proportion to its population, San Francisco receives much fewer catfish than any of the other cities mentioned.

Catfish can not be said to be common in the San Francisco markets. The demand is usually very limited. At times, however, when other fish are scarce, they meet with ready sale at good prices. In 1893 the average daily receipts were less than 150 pounds, and in 1894 under 100 pounds. In no month during those two years did the daily receipts run over 250 pounds on an average, and in July and August, 1894, they were under 30 pounds a day.

The total quantity handled by San Francisco dealers in 1893 was 43,974 pounds; in 1894 it dropped to 31,055 pounds. Smith further

states that the price commanded by catfish in the San Francisco market has greatly decreased in the past few years. In 1888, the average price to consumers was 17 cents a pound; in 1889, it was 10 cents; in 1891, 7 cents; in 1892, 6 cents; and in 1893, 4 cents.

The quantity of catfish handled in Portland, Oreg., in 1893 was 75,000 pounds of dressed fish, with a retail value of \$3,750.

STATISTICS OF THE CATFISH FISHERY IN THE PACIFIC STATES FOR CERTAIN YEARS.

[From statistical reports of the U. S. Bureau of Fisheries.]

Year.	Pounds.	Value.	Average price per pound.
California:			<i>Cents.</i>
1895.....	276,605	\$3,965	1.43
1899.....	465,911	12,734	2.73
1904.....	737,144	20,992	2.71
Oregon:			
1895.....	99,399	1,347	1.35
1899.....	54,360	1,087	1.90
1904.....	180,000	6,000	3.33
Washington:			
1899.....	105,700	2,114	2
1904.....	6,000	300	5

Smith says:

The quantity of catfish taken for sale in the Columbia basin in 1893 was about 90,000 pounds, with a value to the fishermen of \$2,800. Comparatively large numbers were also consumed by lumbermen, farmers, and others who fished for their own use.

The receipts of catfish in Portland in 1893 amounted to 75,000 pounds.

The contention of the California fish commissioners, in several of their reports, that the value of all the catfish caught annually and consumed as food would more than equal the annual appropriation made by the state in the interest of the fisheries and fish culture has probably been verified in a number of years. In 1893, when the fishery is known to have been less extensive than formerly, the appropriation exceeded the value of the catch by only \$1,500.

The last census office preliminary reports give the total catch of catfish in the Pacific States as 1,269,800 pounds, worth \$64,810, or an average price by the pound of about 5 cents (5.1).

According to Smith, fyke nets and set lines or trot lines are the apparatus chiefly employed for taking catfish. Both of these appliances are used in California, but in Oregon only the fyke nets are used. Considerable quantities are taken in some localities in drag seines. In the semiprofessional fishing, hand lines and dip nets are also employed.

INTRODUCTION OF CATFISH INTO FOREIGN WATERS.

General attempts have been made to provide some European waters with American catfish. A number of years ago, at different times, small consignments of *Ameiurus nebulosus* were sent to Europe. They survived transportation very well and the last

accessible records show that they continued to do well after reaching their destinations. What the ultimate results have been the writer has been unable to ascertain.

Available records of shipments of young catfish (*Ameiurus nebulosus* and later *Ictalurus punctatus*) to Europe afford the following data:

November 15, 1884.—One hundred were shipped to Ghent, and on November 28, 95 were received.

July 7, 1885.—Thirty sent to Amsterdam.

June 16, 1885.—Fifty shipped, and later 49 were received in Germany.

July 18, 1885.—One hundred sent to France, and 81 were received in good condition.

June 20, 1885.—Fifty consigned to England, and 48 were received in good condition at South Kensington.

1892.—Five hundred and two sent to Belgium.

1892.—Seventy-six shipped to Germany.

1903.—Four hundred sent to Belgium.

The most of the information possessed by the writer regarding any of these plants is found in early bulletins of the Fish Commission. The following is quoted from the bulletin for 1886, volume VI, pages 197–199:

The first practical attempt in this direction was made in Belgium. Mr. Thomas Wilson, United States consul at Ghent, first suggested placing catfish in the Scheldt, a river which, owing to the large number of factories on its banks, does not contain many fish. It was presumed that the catfish would be particularly adapted to the river Scheldt, because it had been sufficiently proved in America that this fish is not much affected by the refuse from factories. After consulting with Prof. Spencer F. Baird 100 young catfish arrived at Antwerp in November, 1884. By the advice of Professor Baird these young catfish were not immediately placed in the river, but first in the large basins of the large aquarium. It is only after these fish have reached maturity in the aquarium and have spawned there that the young generation should be transferred to the river. This was done, and the young catfish received from America have provisionally been placed partly in a small pond in the botanical garden at Ghent and partly in the Victoria Regia basin in the same garden. The selection of the last place we do not consider fortunate, as the temperature of the water in this basin is certainly much too high for these fish. At present there are in the Amsterdam aquarium 45 catfish, brought direct from New York and placed in a special basin with the hope that they will reach maturity and propagate their species. At present these fish measure from 4 to 6 inches long.

In the same bulletin, on page 138, appears the following, by Dr. Jousset de Bellesme, on the American catfish in the Trocadero Aquarium of Paris:

These fish, which measured 12 centimeters (about 4½ inches) in length, were, in the beginning, owing to their small size, placed in one of the tanks for young fish in the aquarium and remained there till November, 1885, when they were put in the large basin, No. 6.

They were first fed with raw meat, but as they did not seem to take very well to this kind of food they were fed on raw fish chopped fine, which they appeared to like. As soon as they were transferred to the large basin they were fed on live fish.

The water at the disposal of the aquarium is that which comes from the Vanne, whose temperature is 15° C. (59° F.) in August and 9° C. (48.2° F.) in December. It is hardly probable that this temperature is sufficiently high for the reproduction of the catfish. At any rate, those which we have in our aquarium, no matter to what variety they belong, have never spawned.

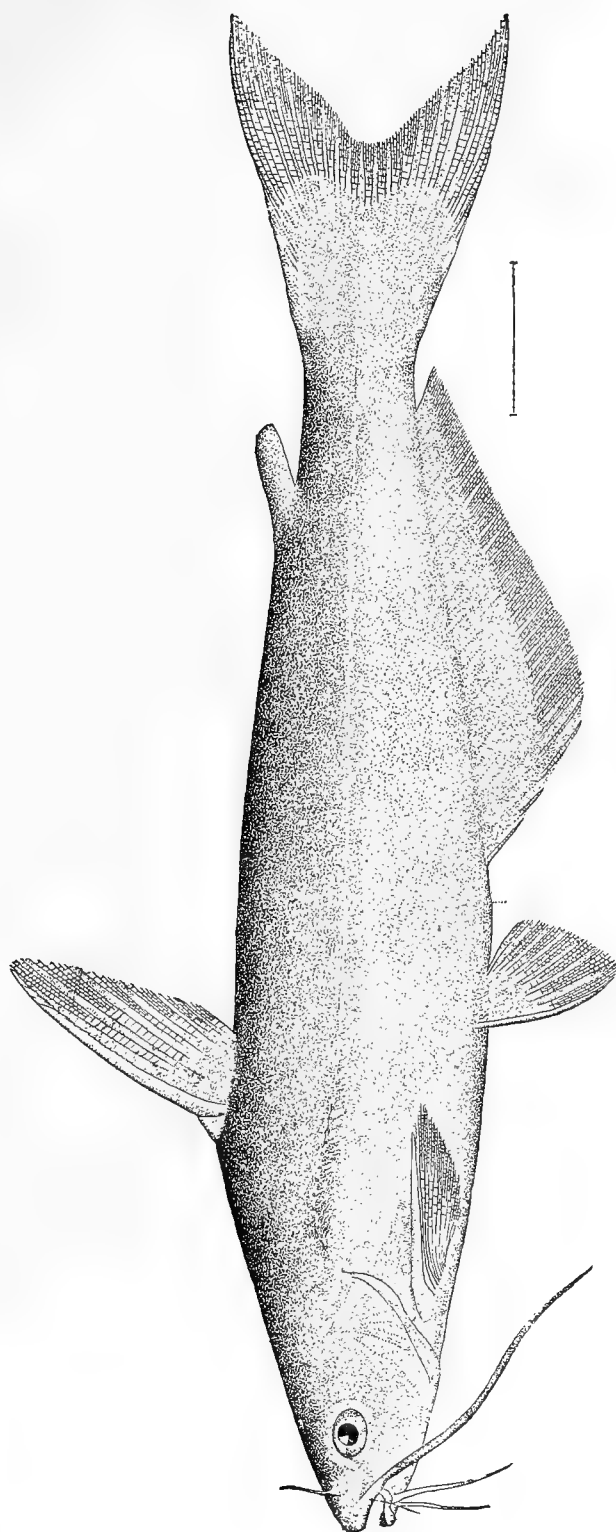
When the American catfish were transferred to basin No. 6, they were all alive and well, although they had not grown perceptibly. Since that time none of them have died, as far as we have been able to observe, for these fish have a habit of keeping in their holes and never coming out during the day, so that they are hardly ever seen. In basin No. 1 we had some of considerable size, and in order to assure ourselves of their existence it became necessary to empty the basin and carefully search for them at the bottom between the rocks. Even then we did not always succeed in finding them. I have, therefore, reason to believe that seven catfish which the Acclimatization Society has given us are still in existence, and the first time the basin is emptied I will search for them again in order to make sure.

The latest information regarding the European introduction is found in a little work entitled "Der amerikanische Zwergwels (Small Cat-fish) und der Fleckenwels (Spotted Cat-fish) in Deutschland," by Max von dem Born-Beneuchen, published in 1891. On page 7 the author states that in the summer of 1885 the committee of the German Fisheries Society received from Prof. Spencer F. Baird in Washington 50 young catfish, which were turned over to his care, and that they were placed in a pond with muddy bottom where there was a great deal of "Wasserpest" and a depth of about 2 meters. They have done very well and increased. Since those brought from America and those held in other fish hatcheries have increased so prolifically, he believes that the small catfish can now be regarded an acclimated fish.

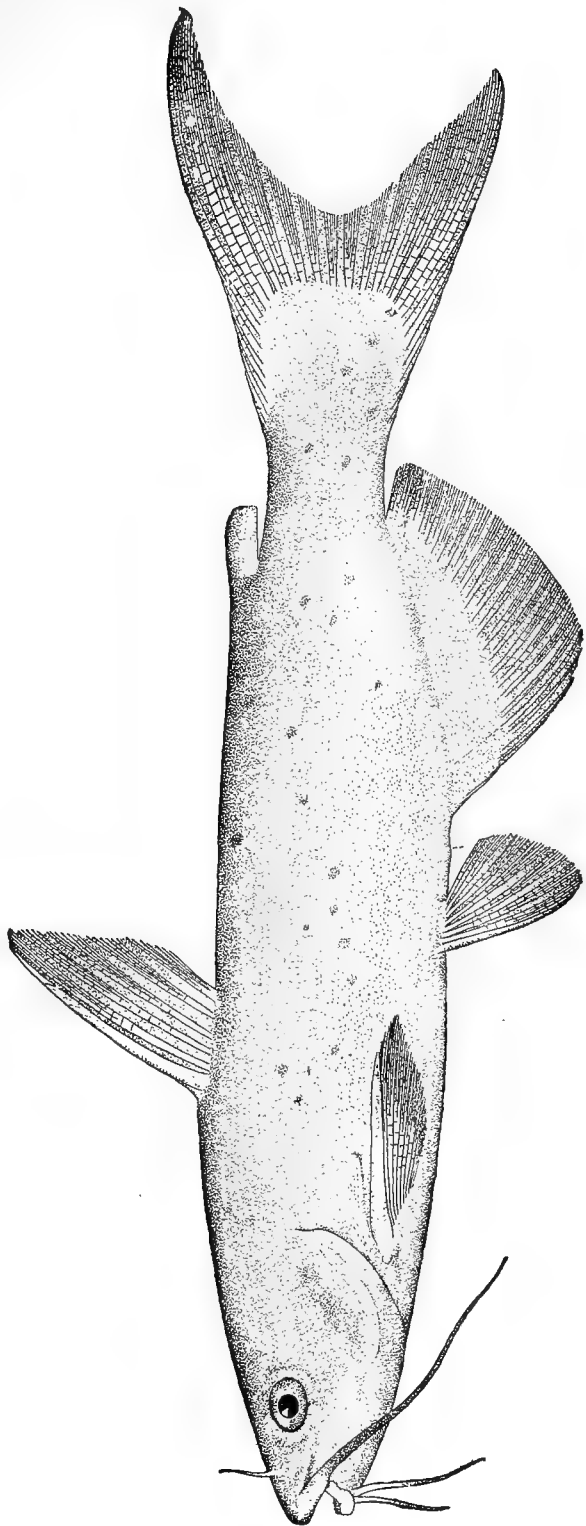
Von dem Born-Beneuchen goes on to say that from 1887 to 1890 he had reared 2,225 one-summer old (*einsommerige*) small catfish; 300 were placed in a lake, 10 breeders and 665 one-summer old fish were given to other fish hatcheries and aquariums, and he now possesses 325 small catfish, for the most part mature (*laichfähig*). On page 8 he continues:

Mr. Fred Mather sent me from the United States Fishery Commission in December, 1888, a quantity of spotted catfish from the Ohio River. Of these, 18 arrived at Beneuchen in good condition, and in February, 1891, 16 fish still lived. They have not yet spawned, although they are already mature in 1890.

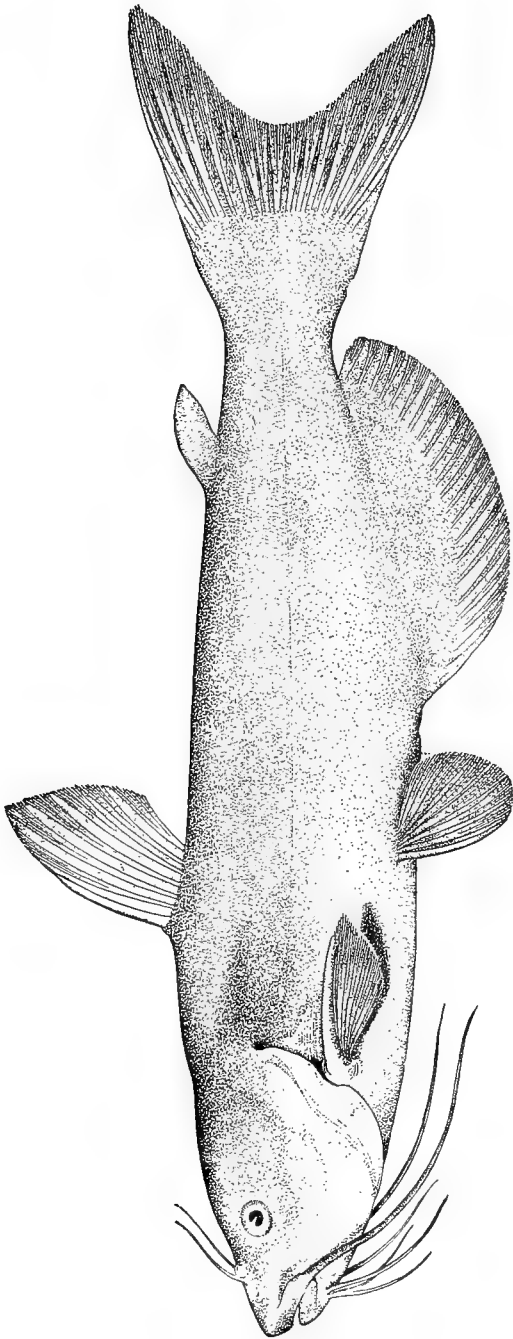




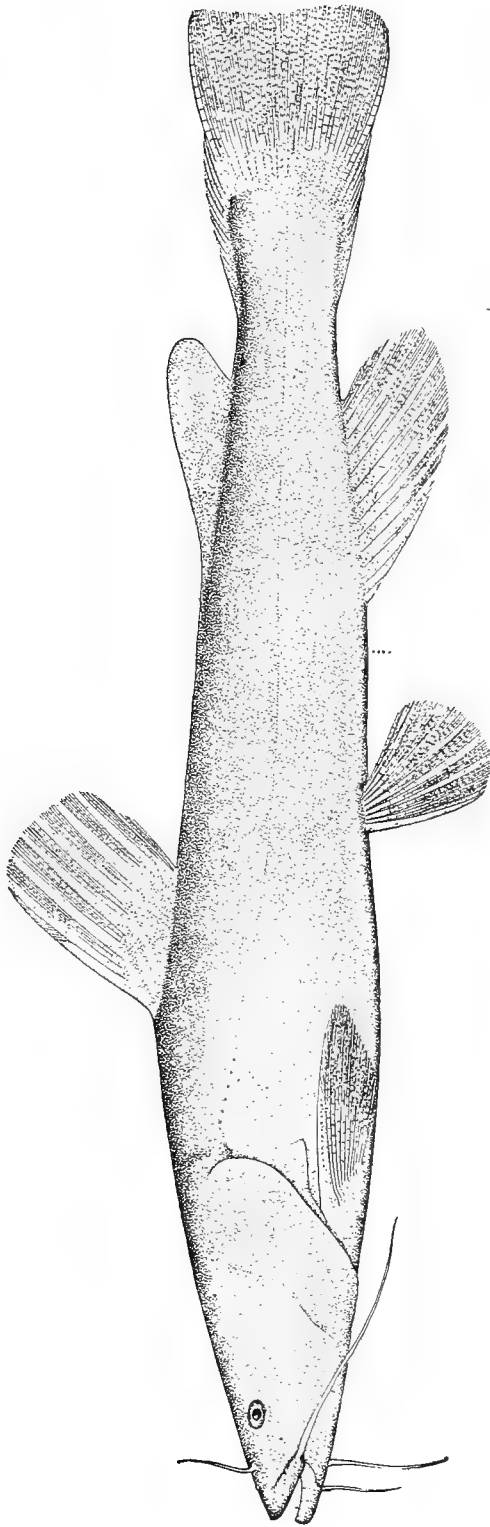
GREAT FORK-TAILED CAT (*Ictalurus furcatus*).



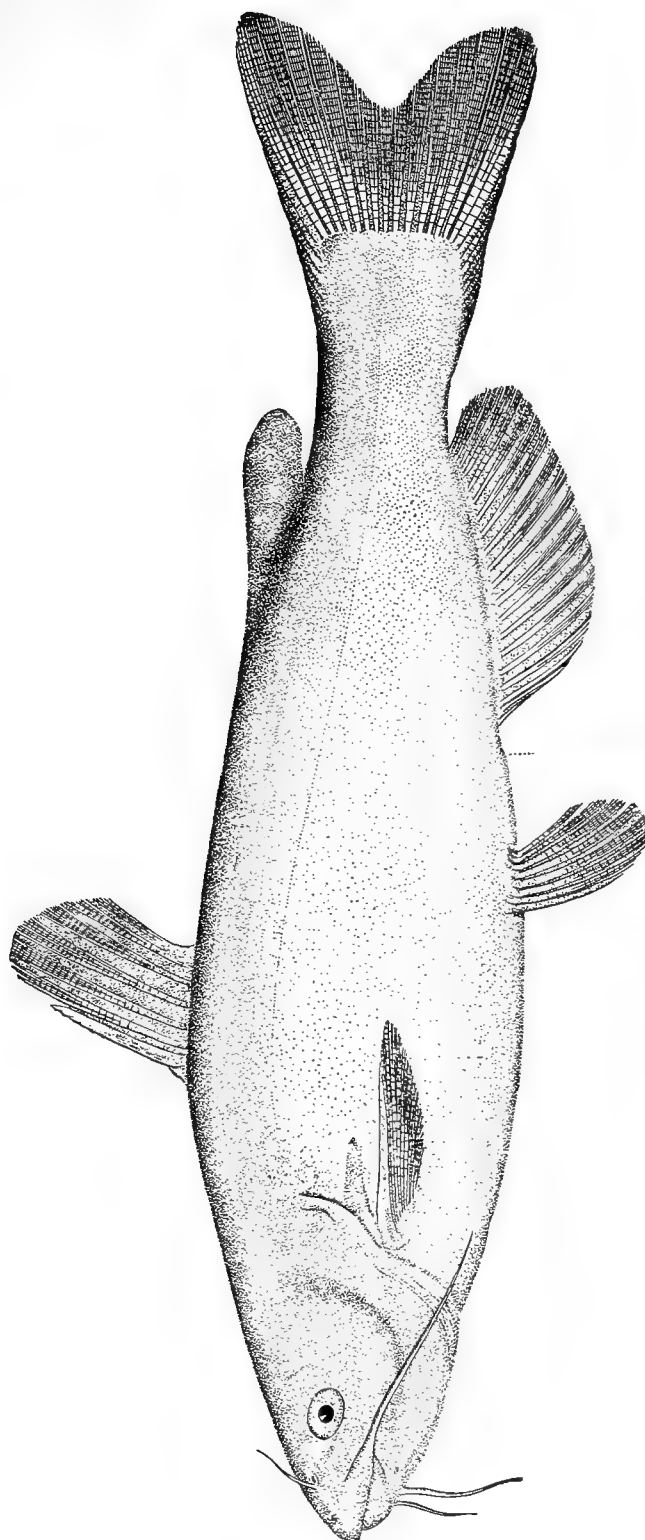
SPOTTED CAT (*Ictalurus punctatus*).



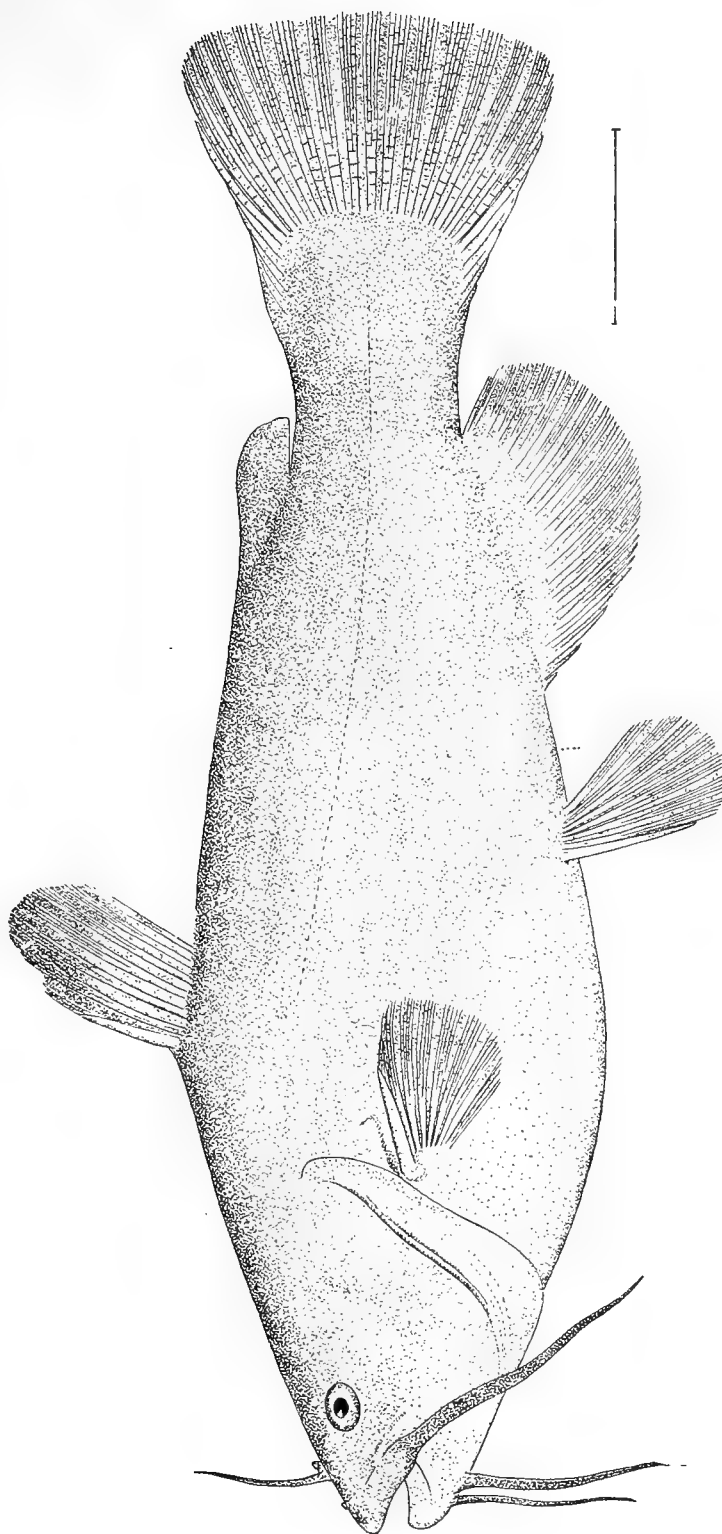
EEL CAT (*Ictalurus anguilla*)



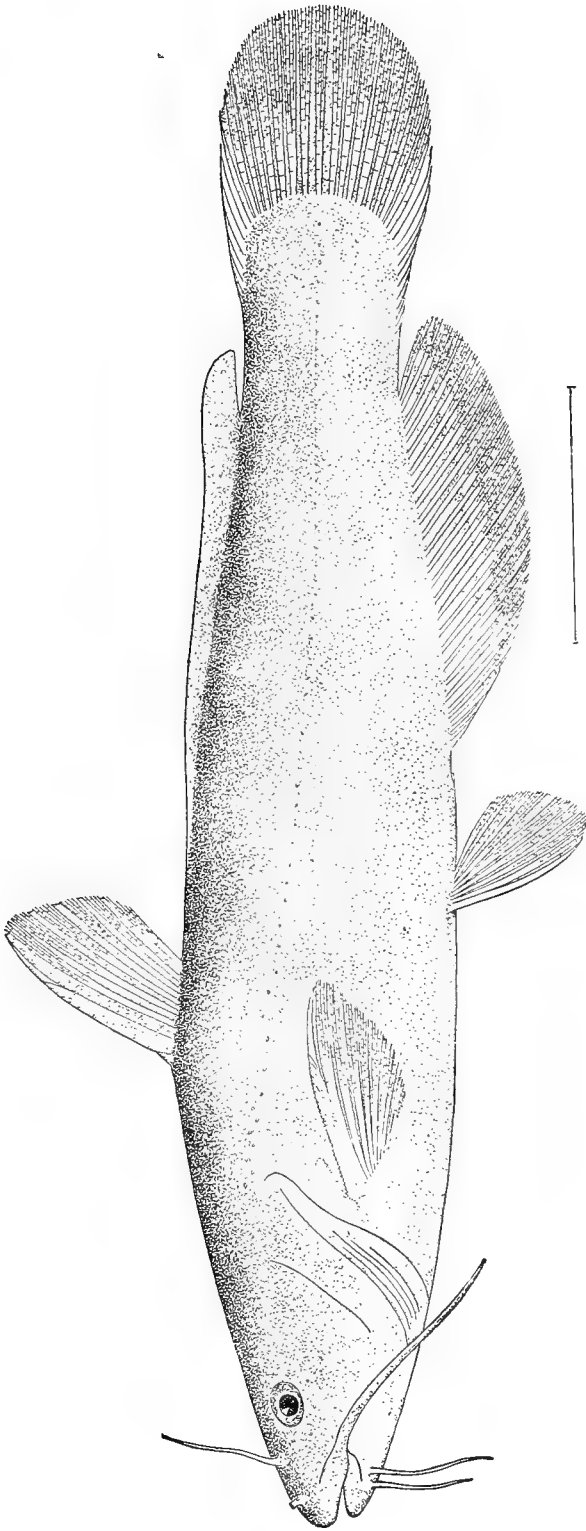
YELLOW CAT. (*Leptops olivaris*).



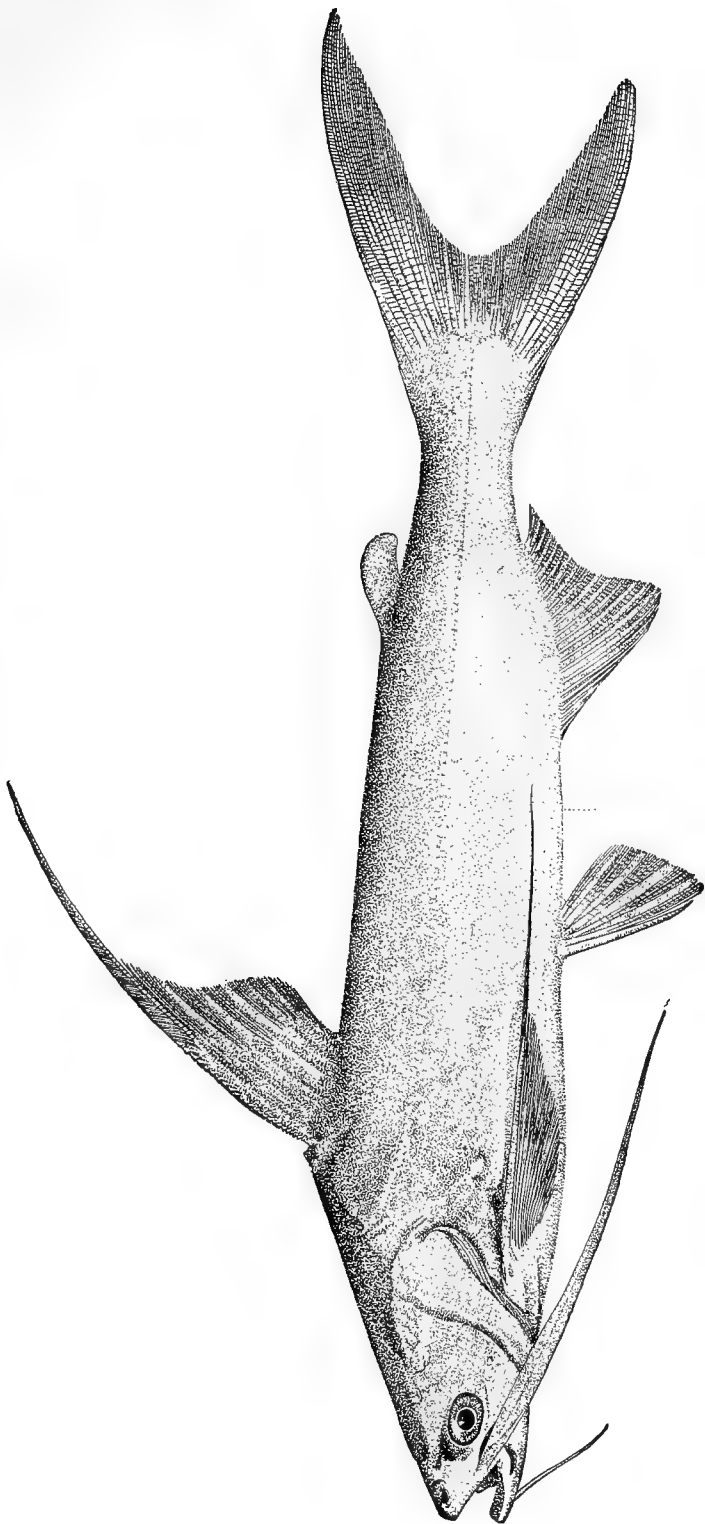
POTOMAC CHANNEL CAT, OR WHITE CATFISH (*Ameiurus catus*).



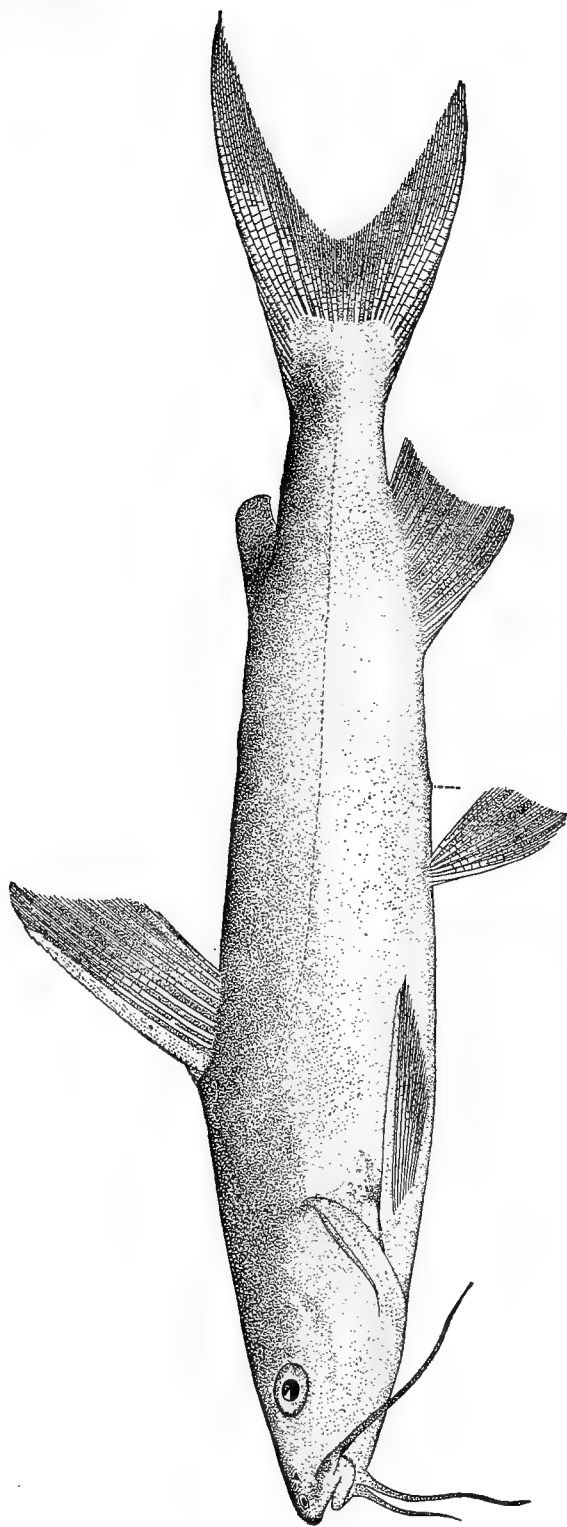
BLACK BULLHEAD (*Ameiurus melas*).



YELLOW BULLHEAD (*Ameiurus natalis*).



GAFF-TOPSAIL CAT (*Felichthys marinus*).

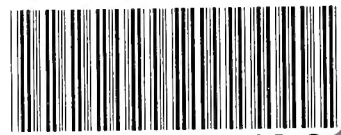


SEA CATFISH (*Galeichthys milberti*).





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